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THE

ORGANIZATION and CELL-LINEAGE

OF THE

ASCIDIAN EGG.

BY

EDWIN G. CONKLIN,

PROFESSOR OF ZOOLOGY, UNIVERSITY OF PENNSYLVANIA.

PHILADELPHIA:

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ORGANIZATION AND CELL-LINEAGE OF THE ASCIDIAN EGG.

By Edwin G. Conklin.

Professor of Zoology, University of Pennsylvania.

WITH PLATES I–XII.

INTRODUCTION.

A. Organization of the Egg.—Recent years have witnessed a revival of the ancient controversy as to the nature and contents of the germ cells. On the one hand are those who with Weismann maintain that the egg must contain the elements or determinants of very many structures which will appear in the course of development; on the other hand are ranged the modern epigenesists who find in the egg cell only complex chemical substances which have the capacity under certain outer conditions of undergoing regular transformations into other substances which incidentally have peculiar forms, just as crystals have.

But while this modern controversy recalls the ancient one between the adherents of evolution and those of epigenesis, it does so chiefly because it proceeds from the same temper of mind, and not because anyone today is ready to defend the views of either the evolutionists or the epigenesists of a century ago. No one now expects to find in the egg or sperm a predelineated germ with all adult parts present in miniature, neither can anyone now maintain that the egg is composed of unorganized and non-living material. Everyone now admits that the truth is somewhere between these two extremes; the real problem is how much or how little of organization is present, and not whether the germ is organized at all.

Though the controversy as to evolution and epigenesis has thus been narrowed within relatively small limits, and has thereby lost much of its startling and picturesque character, it is none the less a real and important controversy today. In general the attitude of physiologists and those who deal with the processes of development has ever been to place emphasis upon the epigenetic character of development and the extremely simple structure of the germ; whereas those who are concerned chiefly with organic structures are prone to seek for antecedent structures in earlier and earlier stages of development and so finally in the unsegmented egg itself.

It is not many years since all embryological studies were dominated by the germ-layer theory, since the time when germ layers were considered to be the earliest appearing differentiations which could be profitably compared and homologized. More recently it has been shown that such differentiations appear at a stage much earlier than the formation of the germ layers, and that many of the early cleavage cells of different animals show such fundamental resemblances

that they can be homologized with one another. May not these differentiations appear at still earlier stages and "organ-forming germ regions" be marked out in the egg before cleavage begins? Finally does the organization of the egg arise *de novo* in the ovary, or may a certain part of it be carried over from generation to generation, and is this early organization of the egg in any way different from the organization of any cell? These are problems of profound importance which lie at the basis of any thorough study of development, inheritance and evolution.

B. Ascidian Embryology.—Anyone who has observed the ascidian egg will understand why it has been such a favorite object of study. The cleavage of the egg is so beautifully regular and can be observed so readily in life that it is not surprising that ascidians were among the first animals to which the "cell-lineage" method was applied. It is surprising, however, to find such diversity of opinion with regard to the development of these animals; even in some of the most important points in the early development, such as the relation of the poles of the egg to those of the gastrula, or the cell origin of the germ layers, scarcely two authors agree, in spite of the fact that these eggs are perhaps as favorable as any others in the whole animal kingdom for the study of these problems. Under the circumstances it is impossible to avoid the conclusion that a large amount of very careless work has been done in this field. Accuracy is ever the avowed aim of science, and when one finds scientific work unpardonably inaccurate he may justly feel indignant. For some reason or other ascidian embryology has ever been a field of conflict and confusion. In some cases controversy has raged for years around a mere blunder which has thus gained a sort of immortality rarely attained by accurate work.

But ascidian embryology furnishes illustrations not only of inaccurate work; it also affords some of the most classical examples of accurate and substantial research. Considering the time when they were written, Kowalevsky's papers (1866, 1871) are models of accuracy. The beautiful studies of Van Beneden and Julin on the segmentation of the ascidian egg and on the morphology of the tunicates (1884, 1886) surpass in excellence anything which had been done up to that time, and in some respects they have not been equalled by any more recent work on the development of these animals. Chabry's (1887) classical paper on the normal and teratological embryology of ascidians is a masterpiece,—one of the first and best illustrations of the application of the experimental method to the study of embryology. After this, the most important work dealing with the early development of ascidians is that of Castle (1894, 1896), although it is marred by some fundamental mistakes; he has applied in detail the method of cell-lineage to the study of the development of *Ciona intestinalis*, and has followed the history of the individual cleavage cells farther than had any of his predecessors. Other work which deserves mention has been done by Kupffer (1870), Seeliger (1885), Davidoff (1889), Samassa (1894) and others, and will be referred to later in the body of this work.

In the face of all this antecedent work, it may seem superfluous to devote yet another paper to this subject, and nothing was further from my purpose when I began. It was in the attempt to find out the manner in which the ascidian egg comes to form its polar bodies at the endodermal pole, as described by Castle, that I was led to conclusions radically different from his, as will be described later, and this induced me to make a detailed study of the cell-lineage of three different genera of simple ascidians. In such a field it may be expecting too much to hope that my observations will meet with general acceptance; but perhaps it may be proper for me to say that I have spared no pains or labor to make them accurate.

C. Material and Methods.—Early in July, 1903, while working at the Marine Biological Laboratory, Woods Holl, Mass., I began the study of the maturation and fertilization of the egg of *Ciona intestinalis* (L.) Flemming, with the aim mentioned in the preceding paragraph. Only a small number of these animals was to be found at that time at Woods Holl, though they occurred more abundantly later in the summer. I therefore turned my attention to two other simple ascidians, *Molgula manhattensis* Verrill and *Cynthia* (*Styela*) *partita* Stimpson, both of which occur in considerable numbers in the Woods Holl region. The very first lot of the living eggs of *Cynthia* which I examined showed a most remarkable phenomenon and one which modified the whole course and purpose of my work; for there on many of the unsegmented eggs, which were of a slate-gray color, was a brilliant orange-yellow spot, which in other eggs appeared in the form of a crescent or band. Further observation showed that this crescent became divided into two equal parts at the first cleavage and that it could be followed through the later cleavages and even into the tadpole stage. I thereafter, for a considerable portion of the summer, devoted myself to the study of the living eggs of *Cynthia*, and a record of these observations will be found in the body of this work and in plates I–V. Afterward I took up also the living eggs of *Ciona* and *Molgula*, and finally I fixed and prepared for microscopical examination, both as whole objects and as serial sections, the eggs and embryos of all three of these genera.

Castle (1896) has described in considerable detail the time and manner of egg laying in these three genera, and his observations I can entirely confirm. The eggs of *Ciona* and *Molgula* are laid in the early morning, a little before daybreak, while those of *Cynthia* are laid in the late afternoon, a little before sunset. These ascidians rarely lay eggs the first day they are in the laboratory. Since the yellow pigment of the egg of *Cynthia* is difficult to observe by artificial light, it was necessary to take eggs from the ovary or oviducts and artifically fertilize them in the morning in order to be able to study by daylight the later stages in the development. A large proportion of such eggs never develop, though the eggs seem ripe and the spermatozoa are active; however, some of them develop into normal embryos and tadpoles, and from such I have obtained material for the study of the later stages of the living egg. Whenever possible, however, I have relied upon eggs which were normally laid and fertilized, inasmuch as all such develop normally. In *Ciona* and *Molgula* it is very easy to artificially fertilize the eggs;

in fact, almost every ripe egg of *Ciona* will develop if fertilized with sperm from another individual, but if fertilized with sperm from the same animal the eggs rarely if ever develop, as Castle has shown. This is due to the fact that such spermatozoa never enter the egg, though they may be quite active. Morgan (1904) has recently discussed this interesting fact in a suggestive manner.

The method which I employed in studying the living eggs of these ascidians was very simple; they were placed in several drops of fresh sea water upon a glass plate and were covered by a large cover glass, which was supported by pieces of thin glass about 200 μ thick. In such condition the eggs can be rolled over at will by pushing on the cover glass, and, if drops of water are occasionally added at the edge of the cover, the eggs will continue to develop normally for two hours or more. Inasmuch as the entire development of *Cynthia* up to the formation of the free-swimming tadpole normally occupies not more than eight to twelve hours, depending upon the temperature, it will be seen that a considerable portion of the development can be followed on a single egg. I do not doubt that with proper precautions the entire development might be followed on a single egg; however, since eggs which have been a long time under a cover glass develop slowly and may become abnormal, and since there was nothing to be gained for my purposes by the observation of a single egg through the whole development rather than of several eggs through consecutive portions of it, I chose the latter and easier method.

All my studies of the living eggs of these ascidians were made with a dry lens, the 4 mm. Apochromat of Zeiss which, with the No. 4 ocular, gives a magnification of about 260 diameters. Even with a magnification of 50 diameters or less the yellow crescent of the *Cynthia* egg is plainly visible. In order to see this crescent to the best advantage, especially with high powers, it is necessary to use wide angle lenses with open diaphragm and clear white light. The fact that Castle studied the development of this species but makes no mention of this yellow crescent is difficult to explain. I can only account for it by supposing that he obtained the eggs in the evening and studied them by yellow artificial light.

Preserved material was fixed in various fluids,—Perenyi's, Kleinenberg's, Picro-Acetic, Sublimate and Sublimate-Acetic. For the study of entire eggs and embryos Kleinenberg's fluid followed by the Picro-Hæmatoxylin, which I have used with success on molluscan eggs, gave incomparably better results than any other method. Eggs so stained were mounted in balsam under thin cover glasses without supports of any kind, and were studied with an oil immersion lens, the 3 mm. Apochromat of Zeiss. By occasionally applying a drop of xylol to the edge of the cover glass the balsam remains sufficiently soft so that the eggs can be rolled into any position desired. For serial sections, material fixed in Boveri's Picro-Acetic gave the most satisfactory results. Such material was stained on the slide in Delafield's Hæmatoxylin and Eosin or in Iron Hæmatoxylin and Bordeau red.

Castle states that he found it necessary to remove the egg envelopes by drawing the egg into a pipette through an opening so small that the egg alone

could pass in, after the manner recommended by Chabry. In most cases I have found that the presence of the egg envelopes does not seriously interfere with clear seeing, possibly owing to the fact that in the study of preparations I have used an immersion lens in which the depth of focus is relatively slight. In late stages, however, the test cells are sometimes confusing, and in the case of *Ciona* I found that these, together with the other envelopes, could be removed by simply rolling the eggs under the cover glass. In *Cynthia* the envelopes may sometimes be removed in the same way, though not so easily as in *Ciona*.

I. THE OVARIAN EGG.

Much has been written on the egg envelopes and ovarian eggs of ascidians and I shall not here go over that ground in any detail. But in searching for the earliest differentiations of the egg substance it is necessary to go back to the ovarian egg, and in so doing I have found some structures the real significance of which has not hitherto been appreciated.

1. *Development of the Ovocyte.*

In a young ovocyte the cytoplasm stains uniformly and there is no trace of yolk or of test cells. Close around the nucleus is a granular mass which is deeply colored by plasma stains, the yolk nucleus or "yolk matrix" of Crampton (1899). As the egg grows, small spherules of yolk begin to appear in the vicinity of the yolk matrix, and this yolk gradually fills the central portion of the egg surrounding the nucleus, while the cytoplasm, which is free from yolk, occupies a peripheral position. Some of the follicle cells which surround the egg at this stage then invade the egg, thus forming the "test cells" which are located chiefly in the peripheral layer of cytoplasm. My observations as to the origin of these "test cells" agree with some of the most careful work, both ancient and modern, which has been done on this subject (Kowalevsky, 1866, 1871; Seeliger, 1882; Van Beneden and Julin, 1886; Morgan, 1890; Floderus, 1896; Bancroft, 1899).

The earliest appearance of polarity is found in the location of the yolk matrix on one side of the nucleus and in a slight eccentricity of the latter. I consider it very probable that the yolk matrix is derived from the attraction sphere of the last ovogonic mitosis, and that the chief axis of the egg represents the cell axis which passes through the centrosome and nucleus, and which, as I have previously shown (Conklin, 1902), is preserved in every cell throughout the cleavage of the egg and probably also in all later cell divisions. If this be true, the polarity of the egg is a differentiation which is carried over from generation to generation, and as this chief axis of the egg is identical with the gastrular axis, and bears a constant relationship to the principal axes of the embryo and adult, it will be seen that at least one important differentiation of an animal is predetermined (not predelineated) at all stages. Although this chief axis of the egg is usually recognizable at all stages by

a slight eccentricity of the nucleus, it is often difficult to observe it after the disappearance of the yolk matrix. No other axial differentiations of the egg are recognizable until after the fertilization.

2. *Test Cells and Chorion.*

In the fully formed ovarian eggs the test cells lie imbedded in a peripheral layer of clear protoplasm; this layer stains intensely with plasma stains, and in the living eggs of *Cynthia* contains yellow pigment granules. In *Cynthia* the test cells are distributed singly and pretty uniformly in this peripheral layer (fig. 61), and the same is true of *Ciona* at an early stage in the formation of the ovocyte (figs. 168, 169), but in the fully formed ovarian egg of *Ciona* the test cells are found in little masses or "nests" of from three to six or eight cells each (fig. 170). A similar grouping of the test cells has been described by Morgan (1890) in an unidentified species of *Clavellina*. These cells are much smaller and more numerous than the test cells of *Cynthia*, and are evidently formed by division of the original test cells.

The test cells of *Cynthia* become quite large and contain yolk spherules, though they do not stain as densely as the yolk of the egg; in *Ciona* the test cells are very much smaller and do not contain these spherules. About the time that the ovarian eggs escape from the ovary the test cells are extruded from this peripheral layer of protoplasm, and the outlines of the egg, which up to this time have been irregular, become more nearly spherical. It is probable that the expulsion of the test cells and the assumption of the regular spherical form by the egg have a common cause in the increase of surface tension at this time.

At the time of the extrusion of the test cells I have observed in the ovarian eggs of *Ciona* a faintly-staining, homogeneous layer which lies inside the outer follicle cells and outside of the egg. The test cells lie on the inner border of this homogeneous layer; from its general appearance it is highly probable that the substance of which it is composed is extruded from the egg along with the test cells. This homogeneous material does not long persist as such but soon disappears and probably goes to form the chorion. At this time the egg undergoes considerable shrinkage in size, a distinct perivitelline space being formed, and the egg becoming regularly spherical (*cf.* figs. 171 and 172). It is evident that this is due to the escape of fluid from the egg, probably the homogeneous substance described above.

In this connection a word or two as to the significance of the test cells may be permissible. The fact that in *Cynthia* they contain yolk and grow to a considerable size, and that spermatozoa not infrequently enter them (figs. 80 and 85 sn.), may be taken as evidence that these cells are rudimentary eggs; a view which is held by Floderus (1896), Bancroft (1899) and others.

3. *Structure of Fully Formed Ovocyte.*

When first laid the living eggs of *Cynthia* are, exclusive of the egg envelopes, about 150 μ in diameter; those of *Ciona* are about the same size, but in *Molgula* they are much smaller, being about 100 μ in diameter. The very large germinal

vesicle contains an abundant granular precipitate, an enormous nucleolus, and at wide intervals within the vesicle, but chiefly near the nuclear membrane, a few deeply staining chromatic granules. These granules are small at this time and it is difficult to determine their exact shape, though many of them appear to be V- or Y-shaped; they are the bivalent chromosomes of the first maturation division. Close around the germinal vesicle and extending out nearly to the periphery of the egg is the yolk, which exists in the form of spherules, imbedded close together in the granular cytoplasm. Finally there is the peripheral layer of deeply staining protoplasm in which the test cells were formerly imbedded and which contains no yolk, but numerous refractive spherules much smaller than those of the yolk.

In the living eggs of *Cynthia* this peripheral layer is clear and transparent and contains uniformly but sparsely distributed yellow pigment, which seems to be associated with these small refractive spherules. This pigment is soluble in alcohol and hence cannot be observed in fixed and prepared material; on the other hand, the alcohol in which large numbers of these eggs have been preserved, has the color of a solution of potassium bichromate. The test cells of *Cynthia* also contain yellow pigment granules which are gathered close around the nuclei of these cells. It is noticeable that most of the viscera of *Cynthia* contain this same yellow or orange pigment, the ovaries being especially highly colored. This pigment is much denser in some individuals than in others, and correspondingly one finds some ova in which there is little or none of the pigment, while in others it is very abundant. In general the animals which have little of the pigment in their viscera are those which produce eggs with little or no pigment, while those in which the viscera are deeply pigmented produce well-pigmented eggs. The central yolk mass of the living egg of *Cynthia* is of a slaty gray color, while the germinal vesicle is clear and transparent. Therefore, in the living egg of this species of ascidian, three areas can be distinguished with great clearness before the maturation divisions begin,—the peripheral layer of protoplasm containing the yellow pigment, the central mass of gray yolk and the clear germinal vesicle.

In *Ciona* and *Molgula* also these three areas are distinguishable in the living egg before maturation, but not so clearly as in *Cynthia*. In *Ciona* the peripheral layer is nearly transparent, the yolk is a brownish red, while the germinal vesicle is also transparent. In *Molgula* both the peripheral layer and the germinal vesicle are transparent, while the yolk is gray, with a faint lilac tinge. A brief inspection of the eggs of *Boltenia* shows that in this genus the yolk is a bright red.

This peripheral layer of protoplasm, which is present in all the ascidian ova which I have studied, is, both in living and in stained material, the most striking feature of the egg before maturation and fertilization. It is surprising therefore that in spite of this fact it has received so little attention from those who have studied the ovarian history of the ascidian egg; in fact, with a single exception, I cannot be sure that it has ever been mentioned by any previous writer on this subject. In his paper on the origin of the test cells, Morgan (1890) figures and describes this "peripheral zone of protoplasm" in an unidentified species of *Clavellina*

from Green Turtle Cay, Bahamas. What may perhaps be the same layer was described by Kowalevsky (1866) as a "gelatinous layer," in which the test cells are at first imbedded; later, about the time of the first cleavage, the test cells move to the periphery of this layer. In these respects this gelatinous layer of Kowalevsky resembles the peripheral layer of protoplasm, but in other respects the differences are very great; for example, Kowalevsky says that this layer is formed by the activity of the follicle cells, that it closely surrounds the blastomeres during cleavage, and that it becomes the gelatinous mantle of the adult, while the cells within it (test cells) form the cells of the mantle. In none of these respects is this gelatinous layer like the peripheral layer of protoplasm described above, and I am in doubt whether Kowalevsky actually saw this layer of protoplasm or whether he is not describing the perivitelline space between the surface of the egg and the chorion. It is interesting to note that Kowalevsky calls especial attention to the yellow color of the test cells, though he nowhere indicates that he has seen any such yellow pigment in the egg itself. Kupffer (1870), on the other hand, concluded that the test cells were formed by free cell formation from the substance of the egg, because "*die Zellen gleich Anfangs genau die Farbe des Dotters haben*"; however, he nowhere indicates that the peripheral layer of the egg differs in any way from the remainder. In not one of the many later papers on the ascidian egg can I find any reference to this peripheral layer of protoplasm, except in that of Morgan already referred to. In view of the ease with which it can be seen, both in living and in stained material, and of the very important part which it takes in development, this is most remarkable and inexplicable. If due attention had been given to this feature of the ascidian egg, it is safe to say that some of the most conflicting accounts of ascidian embryology would never have been written.

A peripheral layer of protoplasm, entirely similar in structure to that of the ascidian egg, has been observed and described by Sobotta (1897) in the egg of *Amphioxus*. In this case Sobotta says that the peripheral layer gives rise in large part to the inner egg membrane, which forms about the time of the maturation, but even after the formation of this membrane a portion of this layer may remain at the periphery of the egg. Sobotta speaks of the desirability of observing this layer in the living egg, and from what I have seen in the ascidians I can but emphasize this suggestion. In the ascidians this layer does not disappear with the formation of the egg membrane, to which it contributes, but collects at the lower pole when the egg is fertilized; from Sobotta's figures I judge that the same thing happens in *Amphioxus*.

The colors of ascidian eggs deserve some notice at this place. In 1870 v. Kupffer observed in the living eggs of *Ascidia canina* (*Ciona intestinalis ?*) that in the early stages of the ovarian egg the oöplasm is yellow; later, as the egg ripens, this color changes to a brownish red (Kupffer, 1870, p. 10). In the later stages of development this red color is limited entirely to the walls of the alimentary tract. In different animals and at different periods of the year Kupffer found that this color varied from a bright red to an orange tone (p. 17).

Van Beneden and Julin (1884, pp. 4 and 5) call attention to the fact that *Corella parallelogramma* produces two kinds of eggs, one yellow the other gray in color. Both kinds of eggs develop normally and in the same manner and give rise to larvæ, the endoderm cells of which are colored yellow or gray. *Clavellina rissoana* also produces two differently colored kinds of eggs, one pure rose the other yellowish in tint. All eggs produced by the same individual have the same color.

In the species of *Clavellina* studied by Seeliger (1885) the color of the protoplasm surrounding the nuclei of the cleavage cells is yellow, as an inspection of his figures of the living eggs shows (*v.* his plate I).

These cases, taken in conjunction with my observations on the eggs of *Cynthia*, *Ciona*, *Molgula* and *Boltenia*, show that the eggs of ascidians are frequently colored; these colors are usually found in the yolk, and in the later development pass into the endoderm cells. In *Cynthia* the peripheral layer is also colored, and this fact leads me to hope that some other ascidian may be found in which still other portions of the oöplasm may be differentially colored.

II. MATURATION AND FERTILIZATION.

These processes are so intimately associated in the ascidian egg that it is difficult and perhaps inadvisable to treat them entirely separately. As in so many other eggs the entrance of the spermatozoon furnishes some stimulus to the egg which leads to the completion of the maturation divisions. Without this stimulus the egg may remain in the stage of the metaphase of the first polar spindle for hours or even days.

A. Maturation.

1. *Disappearance of Nuclear Membrane.*

The first steps in the formation of the polar spindle take place before the entrance of the spermatozoon. Almost as soon as the egg is laid, and sometimes even before this, the wall of the germinal vesicle dissolves and the clear protoplasm contained within the germinal vesicle moves up to the animal pole of the egg where it may spread out into a cap or peripheral layer (*Ciona*), or may form merely a somewhat flattened disk (*Cynthia*). As soon as the nuclear membrane has dissolved the chromosomes, nucleolus and a granular mass from which the spindle fibres are formed gather together into the center of this area of nuclear protoplasm (figs. 62, 63, 77, 78); since the chromosomes lay at the periphery of the germinal vesicle before its membrane dissolved, this involves a considerable movement on the part of these various constituents. No distinct linin network is visible throughout the germinal vesicle, either before or after its membrane dissolves, and the drawing together of these scattered elements into a central mass must be due to something other than the contraction of the threads of such a network.

The chromosomes, when drawn together into a central mass, are connected by a faintly staining, finely granular substance, which is much denser than the surrounding nuclear protoplasm. In the further development of the polar spindle this mass gives rise to the spindle fibres, and from this fact, as well as from its staining reactions, it may be identified with linin (figs. 62, 77).

The question as to the cause of the dissolution of the nuclear membrane is an interesting one. In a recent work, R. Hertwig (1904) suggests that it is due to the fact that the cytoplasm attacks the nucleus after the cell has ceased to grow. From such observations as I have made I should be inclined to think that the cause was a quite different one,—*viz.*, the continued growth of the nucleus at a more rapid rate than the cytoplasm. In most if not all cases the nuclear membrane dissolves only after the nucleus has exceeded in volume a certain ratio to the cell body. In the ascidian egg the germinal vesicle does not begin to dissolve as soon as the egg ceases to grow; on the other hand, there is a considerable period after the maximum size has been reached before the nuclear membrane disappears; during this period the germinal vesicle continues to enlarge, the test cells are extruded, the secretion which gives rise to the chorion is poured out, the entire egg shrinks in volume, and finally the nuclear membrane grows very thin and disappears. This process is in no wise complicated by the presence of a centrosome, since, according to my observations, no centrosomes are present at any stage of the maturation divisions.

2. *Chromosomes.*

Even before the wall of the germinal vesicle dissolves the chromosomes may be distinguished as small deeply staining bodies, some of which at least are V- or Y-shaped (fig. 76). They are small and numerous, and I have not been able to count them with any assurance of accuracy. After they have been drawn together into the center of the nuclear area, as described above, they become a little larger and are plainly V-shaped (figs. 62, 63, 77). When the spindle fibres appear they are at first widely scattered on or among these fibres (figs. 63, 79, 80), and only in the metaphase do they become arranged in an equatorial plate (fig. 66). In the splitting of the chromosomes the daughter halves first separate at the apex of the V and remain longest connected together by the two limbs; this double V, with the apices pointing to the two poles of the spindle, is then stretched out until the two limbs of each V come to lie near together, thus forming a double Y, each with a long stem pointing to opposite poles; even the little space between the limbs of the Y may disappear, thus forming cross-shaped chromosomes (fig. 66). After the daughter chromosomes have separated they are plainly V-shaped (figs. 67, 68); and this shape may also be seen in the first polar body and in the second polar spindle (figs. 68, 69). In the second polar spindle each limb of the V is separated from the other, thus giving rise to rod-shaped chromosomes, which are found in all the stages of the anaphase and in the second polar body (figs. 70–73). Owing to the small size of the chromosomes it has not been possible to determine with certainty which of these maturation divisions is reducing and which equational. If the two limbs of the V's in the first maturation represent two individual chromosomes united at one end, then the first maturation division is equational and the second reducing, for these limbs of the V's are not separated until the second maturation; if, on the other hand, the cleft in the original V's represents the splitting of two original chromosomes placed side by side (a thing which seems

likely, since such parallel chromosomes without any cleft are found in early stages (*cf.* figs. 76, 62), then the first maturation division would separate whole chromosomes and hence be reducing, while the second would separate half chromosomes and therefore be equational. Only a careful investigation of the manner of origin of these V-shaped chromosomes would finally solve this problem, and this material is unfavorable for such work.

3. *Nucleolus.*

The nucleolus of the germinal vesicle is large and is frequently vacuolated; it usually lies eccentrically in the germinal vesicle, though its position bears no constant relation to the polarity of the egg. As is usually the case, it begins to dissolve at the same time that the nuclear membrane does, and it disappears with great rapidity, so that no trace of it is left by the time that the first maturation figure has reached the metaphase. In this respect it differs materially from the nucleolus of many other eggs, where its solution is so slow that it may not disappear until late in the first maturation division. In this case the solution of the nucleolus is hastened by its breaking up into many small fragments (figs. 62, 63, nl.).

4. *Spindle Formation.*

My observations agree entirely with those of Boveri (1890), Julin (1893), Hill (1895), Castle (1896) and Crampton[1] in showing that there is no trace of a centrosome at either pole of either of the maturation spindles at any time in their history. These results are directly opposed to those of Golski (1899), who found minute centrosomes at the poles of the maturation spindles of *Ciona intestinalis*. Not only are no centrosomes visible in my preparations at the poles of the spindle, but all evidences of astral radiations are also absent. Under these circumstances the formation of the spindle is of unusual interest. The spindle fibres first appear as lines of granules, which radiate in all directions from the finely granular mass of linin substance which unites the chromosomes in the middle of the nuclear area (fig. 62). These lines of granules are quickly transformed into fibres which run through the linin substance: these fibres are never parallel at their first appearance and frequently radiate in all directions, though they sometimes run in the same general course (figs. 63, 64). As this mitotic figure with the surrounding nuclear plasm is moved nearer and nearer to the surface of the egg the fibres come to be more nearly parallel, becoming paratangential with the egg surface (fig. 65). In this rearrangement of the fibres they are at first farthest apart at the ends, so that the spindle has an hour-glass shape (fig. 65). Then certain of these fibres unite at their ends into several groups or bundles, but the fibres which belong to one group at one pole may be associated with different fibres at the opposite pole (fig. 65). There is thus formed a kind of multipolar spindle, closely resembling the mitotic figure present in many plants (*cf.* Osterhout, 1897; Mottier, 1897;

[1] I am indebted to Dr. Crampton for the privilege of seeing photographs of the beautiful plates of his completed but yet unpublished work on the maturation and fertilization of *Molgula*.

Nemec, 1899). Finally, in the metaphase all the spindle fibres are drawn together at the poles; but even in this stage, though the spindle fibres lie close together, they do not unite into a central body, and there are no astral rays (fig. 66). In the anaphase a few rays may be seen running from the margin of the chromatic plate toward the equator of the cell and lying on the periphery of the spindle (figs. 67, 81, 82). These are the only fibres which are not continuous from pole to pole, and are therefore the only ones which bear even a remote resemblance to astral rays; that they are not such, however, is shown by the fact that they radiate from no center but lie only around the periphery of the spindle. In this respect they more closely resemble peripheral spindle fibres than astral rays. Still, if one considers that one of the characteristics of peripheral spindle fibres is that they are attached to chromosomes, it will be seen that these fibres do not belong in that category. Of course, since centrosomes are not present, there can be no central spindle. We have in this case, therefore, a mitotic figure in which are neither central spindle, peripheral spindle nor astral rays in the strict significance of those terms. The spindle which is present arises wholly from nuclear linin, and consists almost exclusively of fibres which are continuous from pole to pole.

The small size of the maturation spindles of the ascidian egg is notable as contrasted with the great size of the germinal vesicle. Among many annelids and mollusks the first maturation spindle is at least as long as the diameter of the germinal vesicle, whereas among the ascidians it is scarcely more than one-quarter as long. However, in those animals in which the spindle is very long in the prophase or metaphase it undergoes a great shortening in the anaphase,—*e. g.*, in *Crepidula* it is not more than half as long in the anaphase as in the metaphase (Conklin, 1902). This is probably true of all cases in which the maturation spindle is a large one; for, since division of the cell body regularly takes place through the equator of the spindle, the spindle must be relatively short at the time of the division of the cell body, or the polar body will be relatively large. In all those cases in which the first polar spindle is a long one, centrosomes are present near the periphery of the germinal vesicle before its membrane disappears and the loose linin network of the nucleus is transformed into the spindle fibres, thus forming a large, loosely constructed spindle. Later, by contraction of these fibres, the spindle shrinks in all dimensions. In the ascidians, on the other hand, no centrosomes are present and the shrinkage of the linin takes place before the spindle is formed, so that from the first it occupies but a small part of the volume of the germinal vesicle, and is no larger at the beginning of mitosis than at its close.

The second maturation spindle arises in part at least from the remains of the first, and is about half as large. Here also there is no trace of centrosomes or astral radiations at any stage. The spindle is barrel-shaped, and a few peripheral fibres are found around it in the anaphase (figs. 69–72); in all respects it closely resembles the first maturation spindle.

Such a case of mitosis as this, in which we have the formation of a spindle, the separation of chromosomes and the division of the cell body entirely without the presence of centrosomes, offers a valuable opportunity for the study of the mechanics

of indirect cell division. Inasmuch as some of the cleavages also throw light on this problem, its further consideration will be postponed to the section which deals with the first cleavage.

5. *Movements of Spindle and of Nuclear Plasm; formation of Polar Bodies.*

In *Cynthia* the first maturation spindle and the surrounding nuclear plasm remain indefinitely in the condition shown in figures 77 and 78 unless the egg be fertilized. In *Ciona* the stage at which the maturation processes come to rest is a little more advanced than in *Cynthia*, as is shown in figure 172; the peripheral layer of protoplasm is here collected over the lower hemisphere of the egg, and the nuclear plasm which has escaped from the germinal vesicle forms a layer over the entire upper hemisphere. Unfertilized eggs may remain in this condition for at least three or four hours and still be capable of fertilization and normal development; but if they remain unfertilized for ten or twelve hours the nuclear plasm spreads

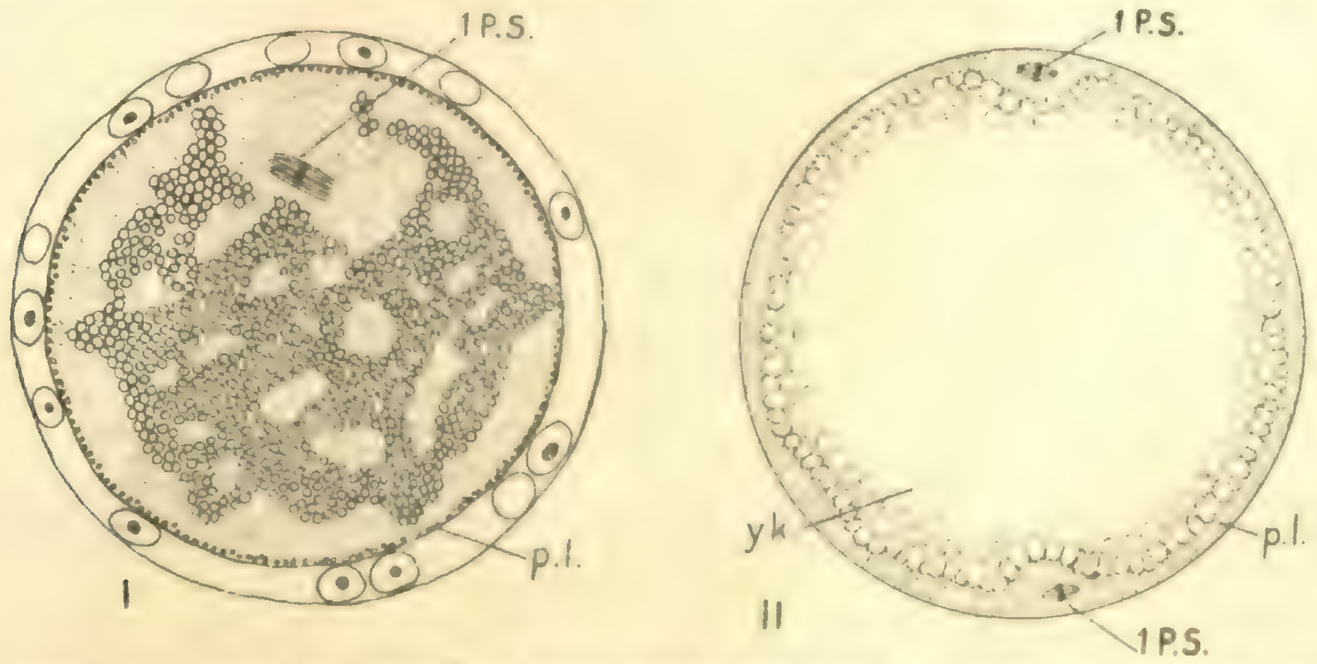


FIG. I.—Section of an egg of *Cynthia partita* which had lain twelve hours without being fertilized. The first polar spindle (1 p. s.) lies in the position in which it was first formed; the peripheral layer of yellow protoplasm (p. l.) remains uniformly distributed over the surface, but the clear protoplasm has spread throughout the yolk and broken it up into irregular masses (compare with figs. 77 and 78 showing unfertilized eggs in normal condition).

FIG. II.—Stained preparation of an entire egg of *Cynthia partita*, showing small spindles at opposite poles (1. p. s.), which are possibly two first maturation spindles, though more probably one of these is a precociously developed sperm spindle.

through the substance of the yolk in irregular masses (*cf.* text fig. I), and the eggs thereafter are not capable of normal fertilization. The maturation and further development of the egg are finally and forever halted in this early stage unless the egg be fertilized. As soon as a spermatozoon enters the egg active movements of the protoplasm begin and a localization of different öoplasmic materials occurs, which will be described later: at the same time the first maturation spindle moves to the animal pole and is turned from a paratangential to a nearly radial position. The daughter chromosomes then separate and the first polar body is extruded (figs. 66–68 and 79–82).

The second maturation spindle is smaller than the first, as Castle has shown, and, like the first, is paratangential in position in early stages and only later becomes radial. The second polar body is extruded close to or immediately under

the first (figs. 71–73). The two polar bodies are of approximately the same size, and neither ever divides. They are at first composed of clear protoplasm in which the chromosomes are free; later the chromatin is dissolved and diffused throughout the cell body, so that they stain deeply and uniformly. They may at all times be distinguished from the test cells by this staining reaction as well as by their being closely attached to or imbedded in the egg. In *Ciona* they may further be distinguished from the test cells by the fact that they are larger than the latter. *In many eggs of Cynthia and in almost all of Ciona the polar bodies remain attached to or imbedded in the egg at the point of their formation, and they thus constitute a most important landmark.*

B. Fertilization.

As has been said, the first maturation spindle remains in the metaphase until the egg is fertilized. The egg remains capable of fertilization for three or four hours at least after the first formation of this spindle. As Castle (1896) has shown, self-fertilization rarely if ever occurs in *Ciona*, though artificial cross-fertilization is most easily accomplished. In *Cynthia*, on the other hand, artificial cross-fertilization is successful in only a small proportion of the eggs.

I have so far been unable to find any artificial means which will cause the unfertilized eggs to develop beyond the metaphase of the first maturation division. Violent shaking, various degrees of concentration or dilution of sea water, solutions of sodium or magnesium chloride of varying strengths have all been without effect in this regard. My experience in this matter is similar to that of Lyon (1903), who reports that he was unable to cause parthenogenetic development among ascidians at Naples by any artificial means.

1. *Entrance of Spermatozoon.*

Of the multitudes of spermatozoa which may be seen burrowing between the follicle cells outside of the chorion after spermatozoa have been mixed with the ova, only a few ever pass through that membrane. I have never seen a spermatozoon in process of passing through the chorion and do not know how it is accomplished. It is possible that there are one or more micropyles at the lower pole, though I have never seen them. In whatever manner the spermatozoa pass the chorion it is done very quickly and several frequently enter the perivitelline space; dispermy or polyspermy, however, is very unusual. A spermatozoon enters the egg in from two to five minutes after the spermatozoa are mixed with the ova, and the presence of supernumerary spermatozoa in the perivitelline space is shown by the fact that some of the test cells are occasionally fertilized (figs. 80, 85, sn).

The spermatozoon always enters the egg near the vegetal pole. I have not found it possible to determine in living eggs whether the point of entrance lies exactly at the vegetal pole or a little to one side of this. In stained preparations of entire eggs, as well as in sections, the entering spermatozoon is usually seen to lie eccentrically with reference to the vegetal pole (figs. 79, 173). In other cases,

however, it lies almost exactly at that pole; in sections this appearance might be due to obliquity of the plane of section to the egg axis, but in preparations of entire eggs it can be seen that the spermatozoon does sometimes enter almost exactly at the vegetal pole. It is unquestionably true that the point of entrance is usually eccentric as Castle affirms, but the degree of eccentricity just as certainly varies in different cases. It might be supposed that this eccentricity always lay in a single definite meridian, were it not for the fact that in cases of dispermy and polyspermy the various points of entrance lie in different meridians (*cf.* figs. 12, 94). I conclude therefore that the spermatozoon may enter at any point on the vegetal hemisphere within about 30° of the pole.

The fact that the spermatozoon always enters near the vegetal pole must be due to some structural peculiarity; the peripheral layer of protoplasm is a little thicker at this pole than elsewhere at the time that the sperm enters, and this might be held to be the cause of the sperm's entering at this pole, were it not for the fact that the sperm enters at the vegetal pole in many other eggs, *e.g.* those of annelids and mollusks, in which there is no periperal layer. It is probable that this very general phenomenon is dependent upon some fundamental property, such as the polarity of the egg or the direction of movement of the egg substance.

2. *Movements of Oöplasm.*

With the entrance of the sperm the most astonishing series of changes takes place in the egg. These changes are most striking in the living eggs of *Cynthia*, where, owing to the yellow color of the peripheral protoplasm, the movements of the egg substance can be directly observed; but they may also be seen in the living eggs of *Ciona*, and a detailed study of these changes may be made on fixed and stained preparations. Almost immediately after the entrance of the spermatozoon the peripheral layer of protoplasm, which is nearly uniformly thick, and the great area of nuclear plasm, in which the first maturation spindle lies (figs. 77, 78), flow around to the lower pole of the egg, leaving the first maturation spindle surrounded by only a small amount of protoplasm. Thus within some ten minutes after the entrance of the sperm the protoplasmic pole of the egg is transformed into the yolk pole and *vice versa*. Castle does not figure nor describe this flowing of the protoplasm from the animal to the vegetal pole, and it is probably owing to the fact that he had not observed the early stages in which this occurs that he describes the polar bodies as being formed at the yolk pole of the egg and the spermatozoon as entering at the protoplasmic pole. Although he says that the presence of a spermatozoon cannot be detected in the egg from which his figure 1 is drawn, I should suppose from the fact that the first polar body is being extruded that the sperm must already have entered (*cf.* my fig. 173).

a. *Localization of Yellow Protoplasm.*

In *Cynthia* this downflow of protoplasm takes place so rapidly that it can be seen in the living egg and with such force that the test cells, which lie between

the surface of the egg and the chorion, are sometimes carried down with the streaming protoplasm to the lower pole of the egg, where they are crowded together and heaped up in the perivitelline space (fig. 3, *et seq.*). While this flowing is most active, streamers of yellow surface protoplasm may be seen radiating toward the upper pole. The yellow protoplasm thus carried to the lower pole collects into a deep orange-yellow spot which surrounds the sperm nucleus (figs. 4–6); it frequently forms a prominence at the lower pole which recalls the polar lobe of the eggs of annelids and mollusks. The clear nuclear protoplasm also flows to the lower pole, where it lies beneath the yellow disk or spot and is visible around its periphery (figs. 4–6). The yellow protoplasm then gradually spreads again until it covers most of the lower hemisphere (figs. 6–10). Then the sperm nucleus moves to one side of this yellow cap, and a large part of the yellow protoplasm is drawn over with it until it forms a yellow band or crescent, in the middle of which the sperm nucleus lies. This crescent lies just below the equator of the egg and its middle point marks the posterior pole of the future embyro, while its two horns reach forward about half-way around the egg to the middle of the right and left sides.

b. *Localization of Clear Protoplasm and Yolk.*

At the same time that the yellow protoplasm is being formed into a crescent and moved up toward the equator on the posterior side of the egg, the clear protoplasm which surrounds the sperm nucleus and aster is also drawn entirely away from the lower pole to the posterior side of the egg and thence up to the equator (figs. 82–92). Up to this time the sperm nucleus and the clear and yellow protoplasm have remained near to the egg surface; finally, after the meeting of the germ nuclei near the posterior pole of the egg, these nuclei and the clear protoplasm surrounding them move inward to the center of the egg, while the yellow protoplasm is largely left at the surface.

When the clear and yellow protoplasm are withdrawn from the upper pole the gray yolk is there exposed (figs. 4, 5, 11). After the protoplasm moves up to the posterior pole the yolk is exposed over the entire egg, except for the area of the yellow crescent and a narrow line of clear protoplasm, which comes to the surface just above the crescent (figs. 13–18).

In sections, small spherules which probably represent the yellow granules of the peripheral layer of protoplasm, may be seen heaped up around the entering sperm (fig. 74), this aggregation corresponding to the yellow spot of the living egg (fig. 6). This massing of the yellow spherules is most marked, while the sperm head lies in the peripheral layer; when it passes through this layer into the deeper layer of clear protoplasm the yellow spherules again spread out into a flattened disk, as shown in figures 75 and 80, which correspond to figures 7 and 8 of the living egg (Plate I). Later, when the sperm nucleus moves to the posterior pole and the yellow protoplasm is drawn over to that side to form the crescent, sections show that this crescent does not lie entirely on the surface, but that it extends for some distance inward toward the sperm nucleus (figs. 87, 90, 92).

In *Ciona* the same type of protoplasmic movement occurs as in *Cynthia*, but with certain minor differences. The peripheral layer is here decidedly thicker at the lower pole than elsewhere, even before the fertilization of the egg; the nuclear plasm or clear protoplasm is also at this stage distributed as a layer over the entire upper hemisphere of the egg (fig. 172). After the entrance of the spermatozoon the protoplasm of both these layers collects at the lower pole. The nuclear plasm and peripheral protoplasm cannot easily be distinguished in living eggs of *Ciona*, but in fixed and stained material the latter stains more deeply than the former (figs. 172, 173). A crescent of peripheral protoplasm is formed here in the same way as in *Cynthia* (figs. 175, 176), and it occupies the same relative position (figs. 179–183). Though Castle did not observe the peripheral layer of protoplasm and its movement to the lower hemisphere it is evident that he recognized at least a part of the crescent. His figures 17 and 45–47 show the middle portion of the crescent in the 2–8 cell stages, and he describes this as an area of finely granular protoplasm, which is clear in the living egg, and out of which the small posterior mesenchyme cells are formed. According to my observations these cells arise from a small part only of the middle portion of this crescent, while the greater part of the crescent gives rise to the muscle and mesenchyme cells of the tadpole. From his figures, as well as his descriptions, it is evident that he recognized only a small portion of the crescent, *viz.*, this median area of "clear protoplasm."

In many eggs of *Ciona*, if not in all, clear protoplasm, which is composed of large alveoles, surrounds the entering spermatozoon (fig. 173). Later, when the sperm nucleus moves to the posterior pole, this clear area moves with it, and in sections in the median plane (figs. 175, 176) forms a clear triangular area in the middle of the deeply staining crescent. There is here shown a marked differentiation of the substance of the crescent which continues to be recognizable throughout most of the cleavage. I have not observed this clear median portion of the crescent in the 4-cell stage, but in the 8-cell stage and thereafter it is plainly visible as a deeply staining cap of protoplasm on each side of the mid-line. It corresponds in the main to the "clear protoplasm" described by Castle, which, as he discovered, marks the position of the sperm nucleus at the posterior pole and which ultimately gives rise to the "small posterior mesenchyme" cells ($B^{7.6}$) at the posterior pole of the gastrula. This same clear protoplasm is present in the middle of the crescent in the *Cynthia* egg, although it is here obscured by the surrounding yellow pigment; in the unsegmented egg it forms a layer of transparent protoplasm over the surface of the crescent, and in the cleavage stages of prepared eggs it is visible as two deeply staining caps of protoplasm similar to those in the egg of *Ciona*; it ultimately gives rise to the small posterior mesenchyme cells which are formed from the middle of the crescent and which are composed of clear protoplasm in which there is no yellow pigment (fig. 48, m'ch.). The substance of the crescent is therefore plainly differentiated from the first into these two substances, clear and yellow protoplasm, which remain distinct throughout the entire development.

3. *Development of Sperm Nucleus and Aster.*

Immediately after it has entered the egg the sperm head is rod-shaped and is frequently coiled or twisted on itself (figs. 74, 79, 173). It decreases in length and increases in width very quickly, and soon appears pear-shaped, the pointed end being directed toward the sperm aster. At first densely staining throughout, it stains less and less densely as it swells in volume, until finally the chromatic and achromatic constituents are easily distinguishable (figs. 80–87). During this process there are no evidences of chromosomal vesicles, the nucleus constituting a single vesicle.

In some cases there is a faint line between the head of the sperm and the egg membrane which represents the middle piece and perhaps a portion of the tail (figs. 74, 79). Very soon after the spermatozoon has entered the egg a small aster, with central clear area and minute rays, appears in the position of the middle piece, between the sperm head and egg membrane (figs. 80, 173). The sperm aster then grows with great rapidity, the rays extend throughout the greater part of the clear protoplasm and even into the yolk and a minute body, the centrosome, becomes visible at the centre of the rays, while the whole aster stains more deeply that the surrounding protoplasm (figs. 81–87).

4. *Path of the Spermatozoon within the Egg.*

The spermatozoon usually enters the egg in a radial direction and keeps right on through the protoplasm at the lower pole until it reaches the deeper lying yolk (figs. 74, 75, 80). This may be known as the penetration path (Roux). The sperm nucleus and aster then rotate so that the aster is directed forward in all further movements, as is true in so many other cases (figs. 80–83). The path described after the rotation is the copulation path (Roux), and it always forms more or less of an angle with the penetration path. While the penetration path may apparently lie in any portion of the lower hemisphere within about 30° of the pole, the copulation path seems to be definitely determined by the structure of the egg. The sperm nucleus and aster move in this path from the neighborhood of the lower pole up to the equator of the egg on the posterior side, all the time keeping near to the surface of the egg (figs. 81–87). But this path is not always the shortest path to the equator; sometimes it is the longest, as in figures 81 and 85, in which the sperm having entered to the left of the lower pole moves across to the right side in the figure and then up to the equator. The point near the equator to which the sperm nucleus moves invariably marks the posterior pole of the egg and of the future embryo, and the copulation path by which the sperm nucleus reaches this posterior pole must lie along the posterior side of the egg; but since the point of entrance of the sperm and the penetration path may lie near to or far from the posterior side, it is evident that they can have nothing to do in determining the position of the posterior pole. And since the copulation path is not always the shortest path to the equator, but may sometimes be the longest, it seems probable that the direction of the copulation path is not the cause but the result of the antero-posterior differentiation of the egg. A further consideration of this subject will be found in the general part of this paper.

5. *The Egg Nucleus and its Movements.*

After the formation of the second polar body the chromosomes left in the egg form chromosomal vesicles which then unite to form the egg nucleus (fig. 73). The latter then moves away from the animal pole into the yolk, apparently in the direction of the axis of the second polar spindle (figs. 86, 87); it soon turns, however, and moves toward the sperm nucleus and aster at the posterior pole. At first a few remnants of spindle fibres connect the egg nucleus with the animal pole (fig. 87), but these are soon lost and thereafter this nucleus, without any surrounding area of protoplasm or astral rays, is almost lost to view in the dense mass of yolk (fig. 89). Finally the egg nucleus emerges from this yolk into the clear protoplasm surrounding the sperm nucleus, and the two nuclei meet at the equator of the egg about half way between the posterior pole and the center. The relative positions of the two germ nuclei when they first meet is invariably the same; the egg nucleus always lying on the central (anterior) and animal pole (ventral) side of the sperm nucleus (figs. 89–93).

6. *Sperm Amphiaster and first Cleavage Spindle.*

About the time that the sperm nucleus has moved to the edge of the yellow cap (fig. 8) and some time before the union of the two germ nuclei, the sperm centrosome divides as shown in figures 88, 89. I have not observed all the details of this division, but it is evident that the centrosome here gives rise to a centrosomal spindle or netrum (Boveri 1901), at the poles of which the daughter centrosomes lie. After the centrosome has divided, the sphere also divides (fig. 88), and a well-marked central spindle is left connecting the two daughter centrosomes (fig. 89). When these daughter centrosomes have moved to the poles of the sperm nucleus the central spindle is curved around that nucleus, and finally its fibres become indistinct (fig. 90) and then disappear altogether (fig. 91). The sperm aster, at the time of its division, invariably lies on the central side of the sperm nucleus, and the axis of the amphiaster thus formed is at right angles to the copulation path and to the plane of the first cleavage (figs. 88–91). Up to the time when the two germ nuclei meet, the sperm centrosomes lie at the poles of the sperm nucleus (fig. 91), whereas no trace of centrosomes are ever found in connection with the egg nucleus, and after the latter has moved away from the animal pole, on its path to the sperm nucleus, no trace of radiations, spindle fibres or even of surrounding cytoplasm can be found near the egg nucleus. The cleavage centrosomes may be traced without a break back to the sperm amphiaster, to the sperm aster and finally to the middle piece of the spermatozoon. There could not possibly be a clearer case of the origin of the cleavage centrosomes from the middle piece of the spermatozoon than is presented by the ascidian egg. This conclusion agrees with the work of all who have ever studied the fertilization in these eggs (Boveri 1890, Julin 1893, Hill 1895, Castle 1896, Golski 1899, Crampton). In *Ciona*, Castle observed an archoplasmic mass in connection with each of the germ nuclei, though that found near the sperm nucleus was larger and more energetic than the

one near the egg nucleus; the latter afterward completely degenerates, according to Castle, and takes no part whatever in the formation of the first cleavage spindle. I have been unable to find this archoplasmic mass in connection with the egg nucleus unless the remnants of the second polar spindle (fig. 87) may be interpreted as such.

Any one who has studied the method of origin of the cleavage centrosomes in the eggs of ascidians and of mollusks cannot fail to be impressed with the profound differences between the two. In the one we have no centrosome or aster in connection with the egg nucleus at any stage, while the sperm centrosome and aster are visible at all stages after the entrance of the spermatozoon, and give rise directly to the cleavage centrosomes; in the other, according to my observations, a centrosome and aster are found in connection with each of the germ nuclei, and coincidently with the union of these nuclei the asters or spheres also unite, while out of this fused sphere material a single centrosome arises in connection with each germ nucleus. It is recommended to those who maintain that in these details of fertilization all animals must conform to a single type that they study the fertilization of a gasteropod as compared with that of an ascidian.

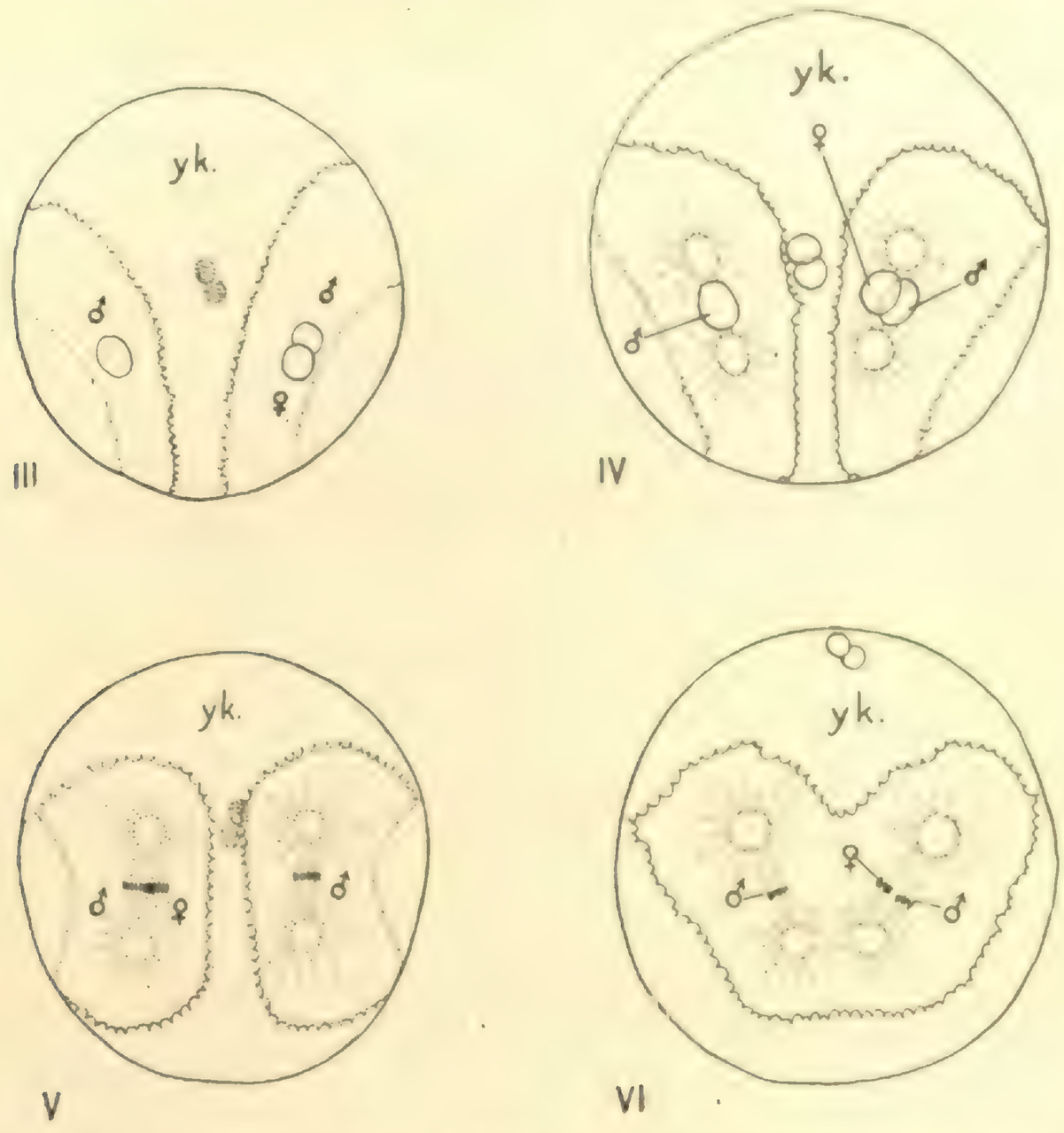
7. *Dispermy.*

Although it is a relatively rare thing for more than one spermatozoon to enter an egg, still eggs are occasionally found into which two spermatozoa have penetrated. The entrance of more than two spermatozoa, if it occurs at all, must be a very rare phenomenon. In stained preparations and in serial sections I have never seen an undoubted case of it; unsegmented eggs are sometimes found in which there are a number of nuclei, but in all cases it is possible that these may have arisen from the division of two sperm nuclei. In living eggs I have sometimes observed several yellow spots on the lower hemisphere. Such an egg is shown in figure 12; there are here four yellow spots, each about equidistant from the vegetal pole, and presumably there is a nucleus in each of these, though nuclei were actually observed in only two of them. It is possible that these may have arisen by division from two original nuclei, and that this is therefore a case of dispermy and not of polyspermy. It is an interesting fact that dispermic eggs never divide, though the nuclei may do so repeatedly, and of course they never develop normally.

Dispermic eggs have been repeatedly observed both in living and in fixed material, in entire preparations and in serial sections. Such eggs afford a valuable means of testing the question as to whether the point of entrance of the sperm is predetermined, and more important still, as to whether the posterior pole of the egg and the plane of the first cleavage is pre-existent in the egg or is established by the entering spermatozoon. So far as I have observed, the two sperm nuclei always enter the egg near the vegetal pole, and at first they lie in a common protoplasmic field. As they move toward the equator, however, they frequently separate, and when they have reached the equator and have each given rise to a spindle they are often found on opposite sides of the egg with the surrounding proto-

plasmic fields quite separate. The two spindles are usually parallel to each other and are always entirely independent, the poles never being united into a triaster or tetraster.

Sections of two dispermic eggs are shown in figures 94 and 95; in the former the sperm nuclei, which have not yet reached the equator of the egg, occupy symmetrical positions on each side of the mid-line, and the protoplasmic field in which they lie is located on that side of the egg which corresponds to the posterior pole of nor-



FIGS. III–VI.—Dispermic eggs of *C. partita*; drawn from stained preparations of entire eggs. Figs. III. and V are viewed from the vegetal pole, the polar bodies being seen through the egg. Fig. IV is viewed from the animal pole and Fig. VI from the posterior pole. The boundary between the protoplasm and yolk is indicated by a crenated line; when seen through the egg this boundary is represented by a line of stipples.

mal eggs. The yellow protoplasm here forms a continuous crescent, and save for the fact that the sperm nuclei do not lie at the middle of this crescent and that a small tongue of yolk partly separates the two sperm asters, the egg is not unlike a normal one. In figure 95 a later stage of a dispermic egg is shown, in which the sperm nuclei have reached the equator and have moved in from the surface toward the center of the egg, while one of these nuclei has united with the single egg nucleus. There is here also a symmetrical arrangement of the sperm nuclei and of the clear and yellow protoplasm on each side of the mid-line. The protoplasmic areas are here further

separated than in the preceding figure, though they still lie nearer one pole of the egg than the other. In this case also there can be little doubt that the more richly protoplasmic pole corresponds to the posterior pole of normal eggs while the yolk-laden pole corresponds to the anterior one.

Other dispermic eggs are shown in text figures III–VI, and here also one hemisphere of the egg contains more protoplasm than the other, and may probably be identified with the posterior pole. In still other eggs, especially those in which the cleavage spindles are fully formed, the spindle and protoplasmic fields may lie on opposite sides of the egg (*cf.* text fig. V). In these cases neither pole can be certainly identified as anterior or posterior. In normal eggs the cleavage spindle always stands at right angles to the chief axis of the egg and to the plane of the first cleavage; in dispermic eggs the spindles are frequently not at right angles to the egg axis and if, as I believe, the plane between the two protoplasmic areas represents the normally median plane, they are more frequently parallel with this plane than perpendicular to it.

The phenomena of dispermy demonstrate that the point of entrance of the spermatozoon is not predetermined but that spermatozoa may enter at different points on the vegetal hemisphere; they also render probable the view that the plane of bilateral symmetry is not first established by the accidental path of the spermatozoon within the egg, but that this plane is structurally present before fertilization. This problem will be more fully discussed in the general part of this paper (Chap. VII).

III. ORIENTATION OF EGG AND EMBRYO.

As a preparation to the study of the cell-lineage and later development of the ascidian egg it is necessary to consider at once the orientation of the egg and early cleavage stages. This is the more necessary since the utmost possible diversity of opinion has been expressed with regard to this matter.

1. *Van Beneden and Julin's System of Orientation.*

Van Beneden and Julin (1884) were the first to undertake to relate the early stages of development of the ascidian egg to the later stages. Their work was in fact one of the earliest and most admirable contributions to the subject of cell-lineage. They followed the cleavage, cell by cell, as far as the 44-cell stage and pointed out what they supposed to be the relations of each of these cells to the germ layers. They determined the relations of the axes of the egg and early cleavage stages to those of the gastrula and larva and, for the first time in the history of embryology, established the fact that the principal axes of the larva may be identified in the unsegmented egg. The evidences upon which they based their conclusions as to the axial relations of egg and embryo and as to the fate of the cleavage cells are not fully stated in their brief paper of only fifteen pages; but their statements of fact are perfectly clear and explicit. In brief these are as follows:

(1) The first cleavage spindle is eccentric toward the posterior pole of the egg, and the median plane of the future embryo is marked out by the bilateral symmetry of the unsegmented egg (p. 6).

(2) The plane of the first cleavage coincides with the plane of bilateral symmetry, and therefore divides the egg into right and left halves (p. 6).

(3) The second cleavage plane is transverse to the long axis of the embryo and separates two large anterior cells from two small posterior ones (p. 7).

(4) The intersection of these two planes marks the vertical axis of the egg; one end of this axis corresponds to the middle of the dorsal, the other to the middle of the ventral face of the gastrula (p. 7).

(5) The third cleavage separates 4 larger dorsal cells from 4 smaller ventral ones (p. 7); the latter are ectodermal, the former "mixed."

(6) At the fourth cleavage these 8 cells give rise to 16; 8 ventral cells, all ectodermal, and 8 dorsal cells, 6 of which are mixed, and 2, which are smaller than any of the others and lie at the posterior pole, ectodermal (p. 8).

(7) By division these 16 cells give rise to 32; 16 ventral cells, all ectodermal and 16 dorsal cells, 4 ectodermal derived from the 2 posterior ectoderm cells of the previous stage, 6 ectodermal derived from the 6 mixed cells, 4 endodermal and 2 still mixed. With regard to the identification of the dorsal and ventral faces at this stage they say:—"Ou bien les cellules ectodermique forment ensemble une calotte appliquée par sa concavité contra les globes endodermiques et mixtes (comme dans fig. 10, c), ou bien c'est le contraire qui a lieu, les globes endodermiques et mixtes s'étalent en surface de façon a constituer ensemble une calotte moulée sur l'ectoderme (fig, 9, c)."

(8) At the next stage there are 44 cells; 32 ectodermal, easily recognized by their transparency, and 12 other cells very much larger. The ectodermal cap is notably extended and tends to envelope the endoderm.

From this stage onward there is no question as to the identification of the dorsal and ventral faces or the anterior or posterior ends. As will presently appear, my work, like that of Chabry (1887), entirely confirms the orientation adopted by Van Beneden and Julin, though I cannot agree with them as to the fate of certain individual cells.

2. *Seeliger's System.*

Seeliger's (1885) later work was much less detailed and satisfactory with regard to the orientation of the early cleavage stages, as Castle has shown. His principal conclusions as to orientation are:

(1) The first cleavage plane coincides with the median plane of the embryo, but neither anterior nor posterior, dorsal nor ventral can be recognized at this stage (p. 48).

(2) The second cleavage divides the egg into two smaller anterior cells and two larger posterior ones (p. 48).

(3) The third cleavage separates 4 dorsal endodermal cells from 4 ventral ectodermal ones; the two posterior ventral cells are larger than any of the others. Structurally all these cells are alike (p. 49).

(4) In the 16-cell stage the 8 dorsal endodermal cells are yellow and have small nuclei; the 8 ventral ectodermal ones are clear (p. 50).

In the identification of individual cells and their axial relations Seeliger was much at fault. The small cells of the 4-cell and later stages are certainly not anterior in position but posterior, as has been shown by Van Beneden and Julin, Chabry, Samassa, and Castle; while the two larger cells of the 8-cell stage are not ventral but dorsal in position, not posterior but anterior, as their relations to the two small posterior cells show. Seeliger therefore mistook anterior for posterior, dorsal for ventral and consequently right for left; in short, he committed all the mistakes possible in orientation.

3. *Samassa's System.*

Ten years after the publication of Van Beneden and Julin's work, Samassa (1894) working on *Ciona* and *Clavellina* reached very different conclusions from those set forth by the first named authors. With the first four conclusions of Van Beneden and Julin mentioned above he agrees, save that in the unsegmented egg he claims that only the median plane and the anterior and posterior, but not the dorsal and ventral, poles can be recognized. With regard to the identification of the dorsal and ventral sides he held that Van Beneden and Julin were completely in error and that they had mistaken the dorsal for the ventral, the endodermal for the ectodermal pole in all stages up to the 44-cell stage. As the most important evidence of this false orientation Samassa cites Van Beneden and Julin's figures 9 c and 10 c, which represent optical sections in the sagittal plane of a 32-cell and a 44-cell stage respectively. In the first of these the ectoderm cells are shown as columnar, the endoderm cells as flattened; whereas in the second, figure 10 c, the ectoderm cells are flattened and the endoderm columnar. "The figures of these two authors," says Samassa, "are sufficient to show that figure 10 c is properly and figure 9 c falsely oriented; in both cases the cylindrical cells belong to the endoderm and are dorsal in position." The words of Samassa directed against Van Beneden and Julin apply with equal or even greater force to himself: "Van Beneden and Julin have not once sought," he says, "to bring forward one fact in support of this remarkable transformation." With the exception of the worthless *a priori* argument that cells which have once been cylindrical must always remain so Samassa has not produced a single argument or fact in favor of his contention.

4. *Castle's System.*

In the same year Castle (1894), in a preliminary paper and again in his final paper (1896) on the early embryology of *Ciona intestinalis*, reversed the orientation maintained by Van Beneden and Julin and held with Samassa that in all stages preceding the 44-cell stage the Belgian investigators had mistaken dorsal for ventral and *vice versa*. Furthermore, after having studied the formation of the polar bodies, he was lead to the truly remarkable conclusion that these bodies in ascidians are formed at the endodermal pole, whereas in all other animals, so

far as known, they are formed at the ectodermal pole of the egg. His conclusions were stated in the most positive manner and have been widely accepted, notwithstanding that such an orientation is absolutely unique, and for this very reason

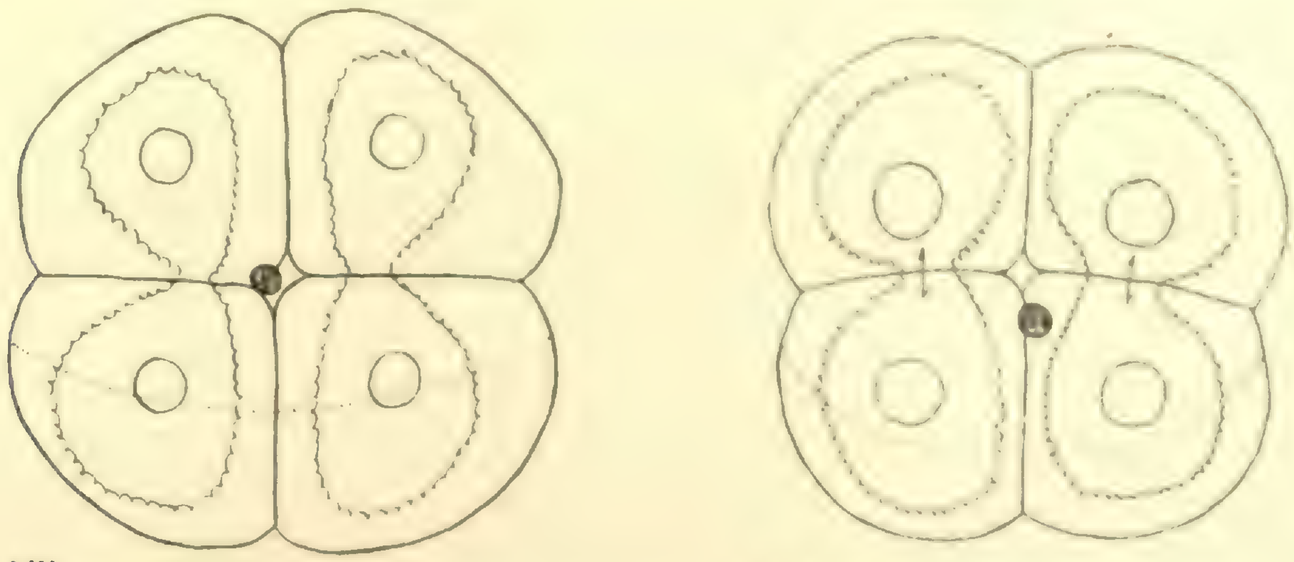


FIG. VII.—Four-cell stage of *Ciona intestinalis* viewed from the animal pole; the crenated line represents the boundary between the protoplasm and yolk; the dotted line marks the anterior limit of the crescent at the vegetal pole; the four cells are approximately equal in size.

FIG. VIII.—Four-cell stage of *Cynthia partita* seen from the animal pole; the limits of protoplasm and crescent are represented as in the preceding figure; the two posterior cells are a little smaller than the anterior ones.

should have been received with caution. Inasmuch as Castle's work is the most thorough and extensive treatment of the early development of ascidians since the appearance of Van Beneden and Julin's paper, and since his conclusions are diametrically opposed to my own, it seems desirable to give with some fulness his conclusions as to orientation as well as the evidences upon which these conclusions are based. In speaking of Van Beneden and Julin's work he says (1894, p. 200):—. . . "It is my purpose to show that by yielding themselves to conjecture in so small a matter as these three cell divisions, the eminent authors fell into an error which invalidates the most important conclusions of their otherwise excellent work. For in correlating the 44-cell stage with the 32-cell stage they have changed the orientation so that they have identified the dorsal side of one with the ventral side of the other, the endodermal half of one with the ectodermal half of the other. *Their orientation of all the stages prior to the 44-cell stage is accordingly wrong. Their terms ectodermal and endodermal, ventral and dorsal, as employed up to this stage. must be interchanged.*" Again with regard to the point at which the polar bodies form he says (1894, p. 211):—"I have repeatedly seen the polar bodies and observed continuously the cleavage stages following their formation. These observations lead to the surprising but unavoidable conclusion that the point on the surface of the egg at which the polar bodies form becomes later the center of the *dorsal or endodermal* half of the egg." Again in his later work (1896, p. 226) he says with regard to this matter:—. . "The form changes accompanying maturation occur, in *Ciona* at least, and presumably in ascidians in general, at the pole of the egg opposite to that at which they occur in *Amphioxus*, and, so far as known, in all other animals producing eggs with polar differentiation; for the changes connected with

maturation are uniformly reported to take place at the animal, *i. e.*, at the more richly protoplasmic pole, whereas in *Ciona* they take place at the vegetative pole. . . . The statement made in the preceding paragraph presents a condition of affairs so directly contrary to that found in other groups of animals, as well as to what has been assumed by all previous writers to be the case in ascidians, that it requires the presentation of unmistakable evidence in its support. Such evidence I have to offer, both from the study of the living egg and from that of preparations."

What is this evidence? So far as it relates to the origin of the polar bodies at the vegetal pole it is twofold; (a) the polar bodies are formed at the yolk-rich pole, (b) this pole becomes the endodermal pole of the gastrula. As to the first of these propositions I have already shown that the germinal vesicle fades and the first maturation spindle appears at the protoplasmic pole (figs. 77, 78, 172). Only later, after the entrance of the spermatozoon, does the protoplasm flow away from this pole, leaving the maturation spindle closely surrounded by yolk; still later, during the first cleavage, the protoplasm flows back again to near the center of the egg and at the close of this cleavage it moves still nearer to the pole at which the polar bodies lie (figs. 100, 102, 106, 107, 178); thereafter this pole is always the more richly protoplasmic. Therefore, except for a brief period after the fertilization and before the first cleavage, when the protoplasm is temporarily withdrawn from the maturation pole through the influence of the spermatozoon, the maturation or animal pole and the more richly protoplasmic pole are one and the same in ascidians as in other animals.

As to the statement that the polar bodies are formed at a point which corresponds to the center of the dorsal or endodermal pole of the gastrula it is evident that unless the polar bodies have been actually followed through the development to a stage when the ectodermal and endodermal poles are unmistakable, this statement must rest upon indirect evidence furnished by a study of the cleavage stages. As a matter of fact, Castle has not figured nor described the polar bodies in any egg later than the 16 to 24-cell stage, whereas there is no trace of gastrulation in *Ciona* before the 76-cell stage (fig. 200). Undoubtedly therefore Castle's evidence that the polar bodies are formed at the endodermal pole must be indirect rather than direct, and must be derived from the study and orientation of the cleavage stages. We may therefore turn at once to the evidences which led him to reverse Van Beneden and Julin's orientation of these stages. So far as I am able to discover there are, in addition to several minor considerations which could at best be considered only as confirmatory, two and only two general lines of evidence which he brings forward in favor of his contention. They are the following:

(1) The hemisphere in which division is earliest as the egg passes from the 16-cell stage to the 32-cell stage, and from the latter to the 46-cell stage becomes later the ventral or ectodermal hemisphere of the embryo (1894, p. 206; 1896, pp. 229 and 235). The second paper refers to this proposition as having been demonstrated in the first. What is this demonstration? So far as I can ascertain it consists merely in the assumption that the cells, which in the 16-cell and 32-cell stages divide earlier

than the others, must continue to divide more rapidly and thus give rise to the more numerous ectoderm cells of the gastrular stage. So far from there being any demonstration of this proposition there is actually no evidence offered in support of it. Furthermore, I can affirm from my own studies that it is not true. The cells which lag behind in division up to the 64-cell stage, thereafter divide much more rapidly than the others and give rise to the ectoderm of the gastrula (*cf.* figs. 130–134 and 196–204).

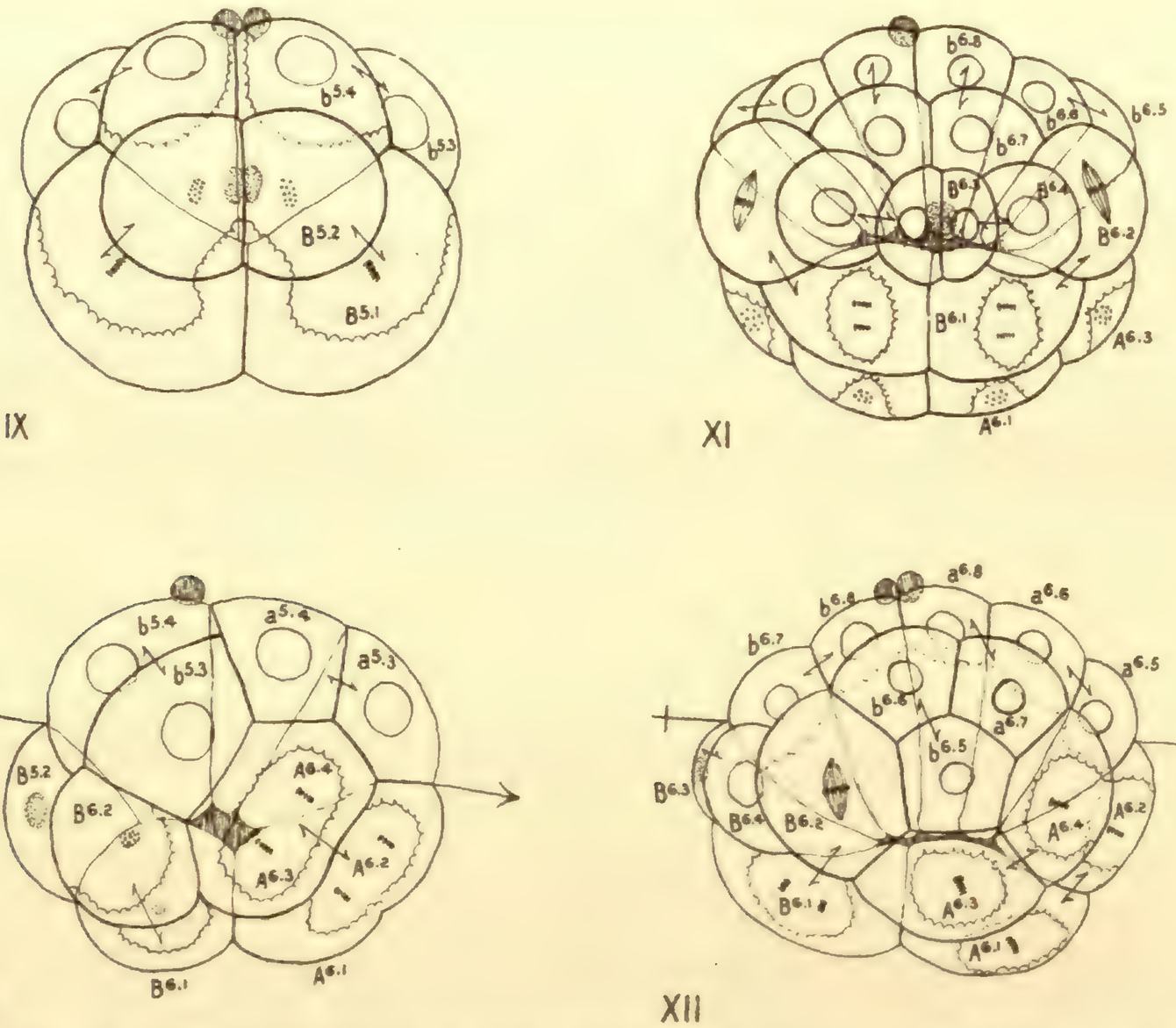
(2) Castle's second reason for rejecting the orientation of Van Beneden and Julin is the same as Samassa's, *viz.*, the peculiar shape of the cells at the two poles. In the 32-cell stage and even earlier the cells at the maturation pole are long and columnar while those at the opposite pole are thin and superficially large. "They [the columnar cells] retain this columnar form up to and throughout gastrulation" (1896, p. 237). They thus give rise directly to the columnar endoderm cells which are ultimately invaginated. On the other hand, Van Beneden and Julin maintained that the flattened cells of the 32-cell stage became the columnar cells of the 44-cell stage and that the columnar cells of the earlier stage became the flattened ones of the latter stage. Castle says that their figures show at a glance the absurdity of such an interpretation (1894, p. 208; 1896, p. 237). Since the whole orientation which he adopts as opposed to that of Van Beneden and Julin rests upon the establishment of this one point, it passes belief that he, as well as Samassa, should not have taken the most evident and direct step to prove it. Van Beneden and Julin figure optical sections in the sagittal plane of an egg in the 32-cell stage showing the columnar cells at the ventral pole, and of one in the 44-cell stage showing them at the dorsal pole. Castle figures actual sections of a 32-cell stage and of a 76-cell stage, but none between these two. A study of actual or of optical sections of eggs transitional between the 32-cell and the 76-cell stages would have shown conclusively that the columnar cells of the former are gradually transformed into the flattened cells of the latter, and the flattened cells of the one into the columnar cells of the other, and would thus have completely established Van Beneden and Julin's orientation. Such a series of optical sections of the *Ciona* egg, viewed from the left side and also from the posterior pole, is shown in text figures IX to XVI, and the various stages in this change of shape can there be clearly followed. A similar series of actual sections of the egg of *Cynthia* is shown in text figures XVII to XXIV. I do not find that this transformation is quite as rapid in *Cynthia* and *Ciona* as is indicated by Van Beneden and Julin's figures 9 c and 10 c for *Clavellina*. At the 44-cell stage the cells at both poles are columnar and of nearly equal height (text figs. XIII, XIV), and not until the 64-cell or even the 76-cell stage is this transformation complete. It must not be supposed, however, that this change in shape of the cells at the two poles is a continually progressive one, since all the cells become more superficial during division and more columnar during rest. Consequently every cell changes shape more or less during each cycle of division; this is well shown in figures XVIII and XX.

Other details which Castle regards as confirmatory of his view will be taken

up later, but enough has now been said, in my opinion, to show the untrustworthiness of his principal evidence against Van Beneden and Julin's system of orientation and in favor of his own.

5. *Evidences in favor of Van Beneden and Julin's System.*

While it is evident from these many and serious differences of opinion that it is easy to make mistakes in the orientation of the ascidian egg, it is not true that the egg is an unusually difficult one to orient. In fact there are few eggs, except

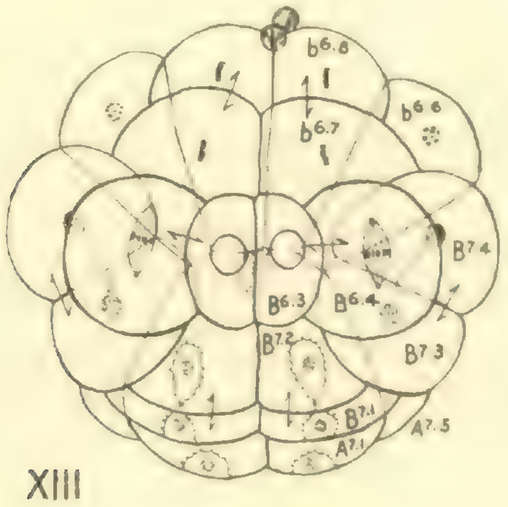


FIGS. IX–XII.—Camera drawings of entire stained eggs of *Ciona intestinalis* viewed as transparent objects. Figs. IX and XI are seen from the posterior pole; Figs. X and XII from the left side. Figs. IX and X represent a 16-cell stage passing into a 24-cell stage; Figs. XI and XII a 32-cell passing into a 44-cell stage. The head and tail of the arrow mark the position of the equator (third cleavage plane) at the anterior and posterior poles. The cells of the crescent (mesoderm) are $B^{6.3}$, $B^{6.4}$ and $B^{6.2}$; all the other cells of the lower hemisphere are yolk laden and the boundary between protoplasm and yolk is indicated by a crenated line; the stippled areas adjoining the median plane in the cells $B^{5.2}$ and $B^{6.3}$ represent caps of deeply staining protoplasm (clear in life). The segmentation cavity is shaded by vertical lines and the cells bordering it are seen in median optical section; the cells at the upper pole are columnar, those at the lower pole flattened. The polar bodies, although shaded diagramatically, are present exactly where they appear in the drawings.

those in which the cleavage is markedly unequal, in which this can be so easily done. All the embryonic axes are clearly distinguishable in the unsegmented egg, and at every stage in development there are numerous landmarks by which the different poles of the egg may be recognized. With the exception of Seeliger, all students of the early development of ascidians have recognized that from the 16-cell stage onward, the posterior pole is marked by two cells much smaller than any others in the entire egg. The chief difficulty has been, as evidenced by the

work of Seeliger, Samassa, and Castle, in distinguishing the dorsal and ventral faces in the pregastrular stages. This is due to the fact that the cells at these two poles are of somewhat similar shape, size and arrangement, as may be seen by referring to figures 117, 118, 120, 124, 130 and 131 of this paper. However, the differences between these poles are so marked that there never need be any confusion regarding them.

(1) The most striking difference between the two poles is found in the fact that at all stages of the cleavage and gastrulation one pole is rich in protoplasm, the other rich in yolk. This is particularly noticeable in *Cynthia* and *Molgula*, but is also true of *Ciona*, though in this genus the differences between the two poles are not



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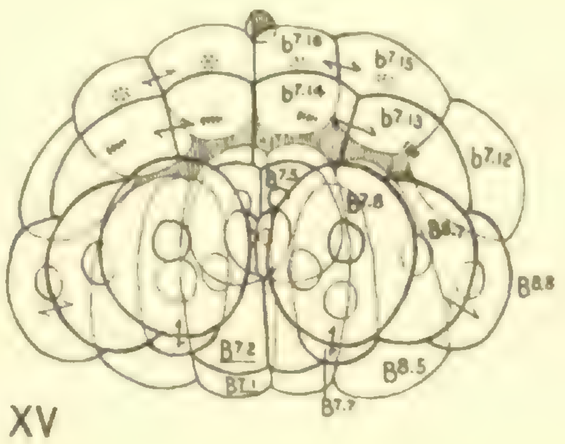

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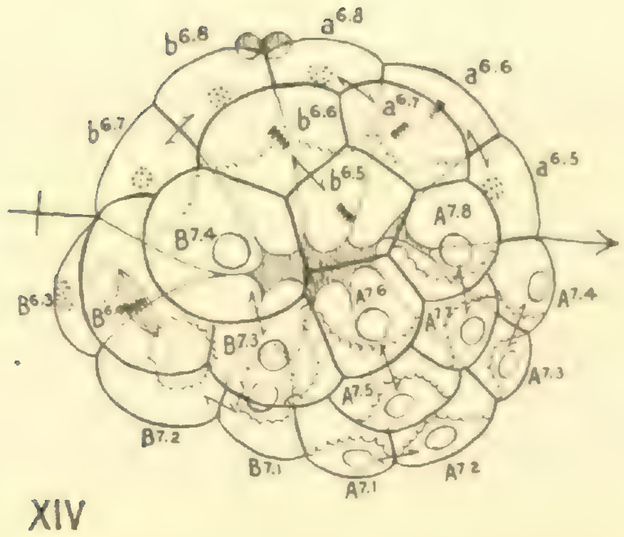

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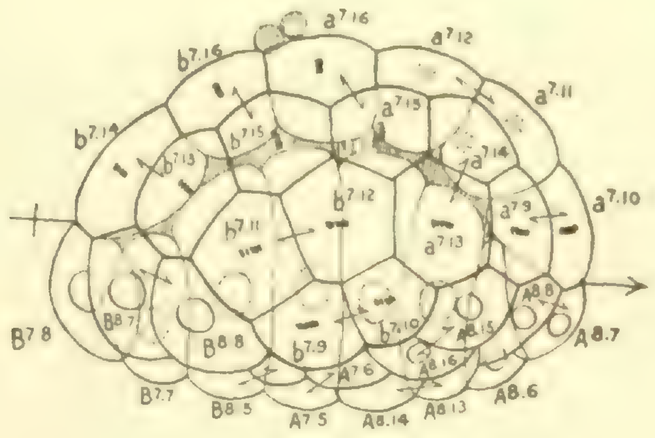
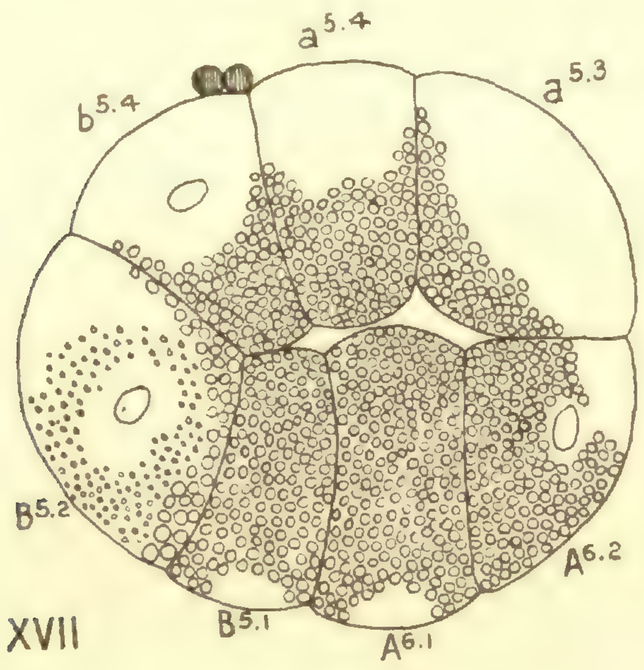


XVI

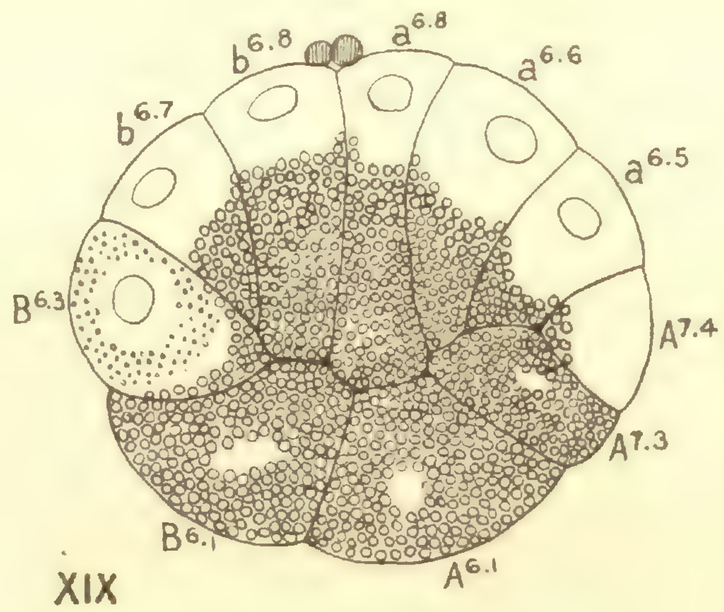
FIGS. XIII–XVI.—Camera drawings of entire eggs of *Ciona intestinalis* viewed as transparent objects; Figs. XIII and XV are seen from the posterior pole; Figs. XIV and XVI from the left side. Figs. XIII and XIV represent a 44-cell stage passing into a 62-cell stage; Figs. XV and XVI a 76-cell passing into a 110-cell stage. The position of the equator, the boundary between protoplasm and yolk and the segmentation cavity are represented as in the preceding figures. In Fig. XIV the cells $A^{7.4}$ and $A^{7.8}$ are neural plate cells, $A^{7.3}$ and $A^{7.7}$ chorda cells; in Fig. XVI the neural plate cells are $A^{8.7}$, $A^{8.8}$, $A^{8.15}$, $A^{8.16}$, while the chorda cells are $A^{8.5}$, $A^{8.6}$, $A^{8.13}$, $A^{8.14}$. The crescent cells (mesoderm) are $B^{6.3}$, $B^{6.4}$, $B^{7.4}$, $B^{7.3}$ (Figs. XIII and XIV) and their dirivatives $B^{7.5}$, $B^{7.6}$, $B^{7.7}$, $B^{7.8}$, $B^{8.5}$, $B^{8.6}$, $B^{8.7}$, $B^{8.8}$ (Fig. XV and XVI). The other cells of the lower hemisphere are endodermal. In Figs. XIII and XIV the cells bordering the segmentation cavity (seen in optical section) are of about equal height at the two poles; in Figs. XV and XVI the cells at the lower pole are columnar, those at the upper pole flattened. The polar bodies are present exactly where they appear in the drawings.

quite so marked as in the other genera named. This difference is so great that in properly stained eggs one can always tell at a glance which is the yolk pole and which the protoplasmic. In eggs stained in picro-haematoxylin the protoplasm is red or light purple, the yolk yellow and the two poles are so unlike that

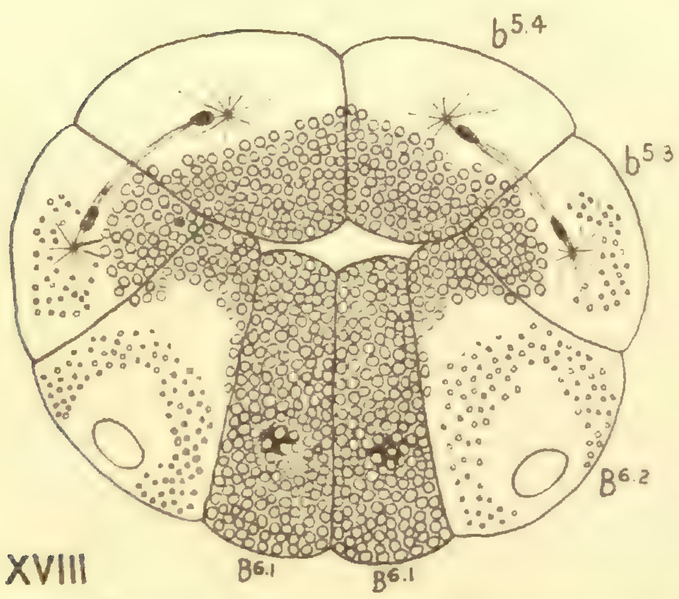
there can be no excuse for mistaking them. In *Cynthia*, indeed, these differences can be easily recognized in the living egg, the yolk being slate-gray and the protoplasm colorless or yellow (figs. 28, 32, 37, 38). The yolk spherules are not scattered through the cytoplasm, but the limits of the yolk and cytoplasm are sharp and distinct. In the cells at the yolk pole the cytoplasm is limited to a small area around the nucleus; at the protoplasmic pole the cytoplasm occupies a large part of the cell, the yolk being limited to the inner ends of the cells. This is seen especially



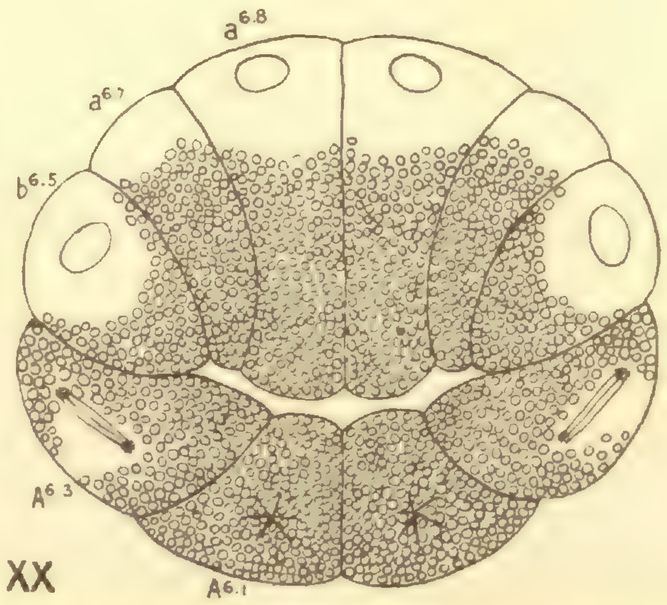
XVII



XIX



XVIII

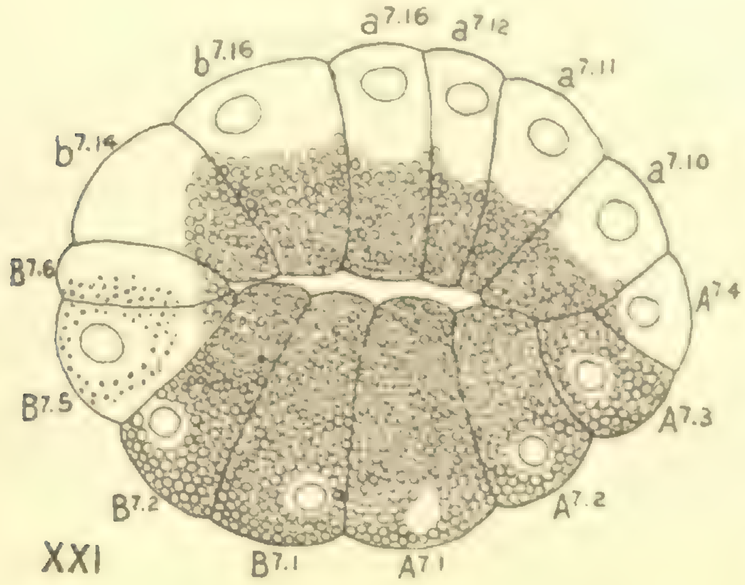


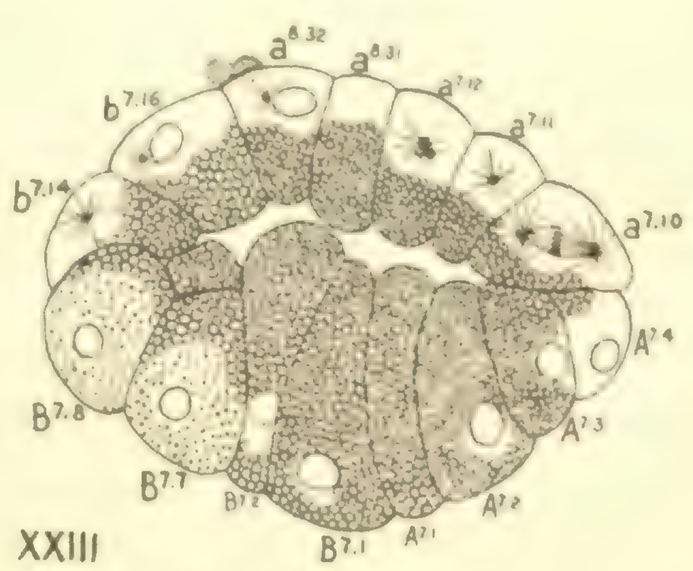
XX

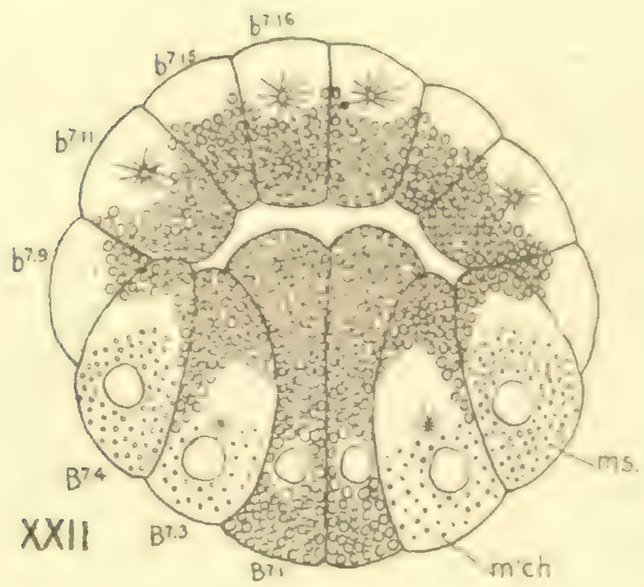
FIGS. XVII-XX.—Actual sections of eggs of *Cynthia partita;* Figs. XVII and XIX in the median plane, Figs. XVIII and XX in a transverse plane. Figs. XVII and XVIII represent a 20-24 cell stage; Figs. XIX and XX a 32-44 cell stage. Unshaded portions of cells represent clear protoplasm; closely crowded spheres, the yolk; minute spherules, the yellow protoplasm of the crescent. The clear protoplasm is located chiefly in the cells of the animal half of the egg (ectoderm); it is also found in the crescent cells (mesoderm) ($B^{5.2}$, $B^{6.2}$, $B^{6.3}$) and neural plate cells ($A^{7.4}$, upper half of $A^{6.2}$) of the lower hemisphere. The remaining cells of the lower hemisphere, (endoderm $B^{5.1}$, $B^{6.1}$, $A^{6.1}$, $A^{6.3}$, and chorda, $A^{7.3}$ and lower half of $A^{6.2}$) are filled with yolk; yolk is also found in the central ends of all the other cells. The yellow protoplasm is limited to the crescent cells and to a single pair of cells of the upper hemisphere ($b^{5.3}$). In Fig. XVII the cells at the two poles are approximately equal in height; in Fig. XVIII the cells at the animal pole are flatter, probably owing to the fact that they are dividing; in Figs. XIX and XX the cells at the animal pole are columnar, those at the vegetal pole flattened. The polar bodies are actually present where they are represented.

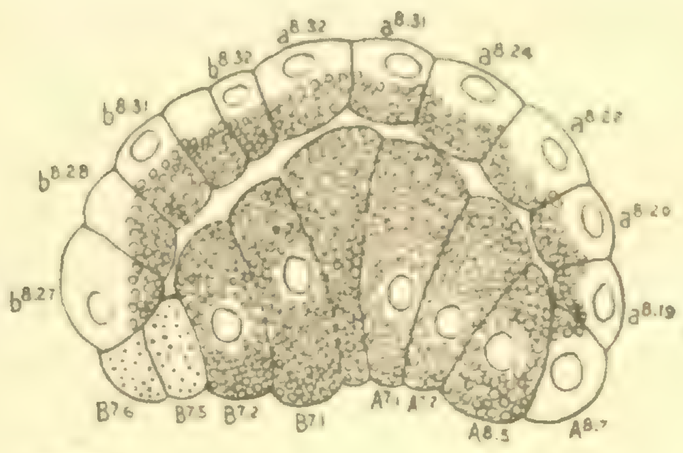
well in actual sections taken in the egg axis; such sections are shown in text figures XVII to XXIV, and it can there be seen that the cytoplasm is largely found in those cells which lie on that side of the egg where the polar bodies are found, while the cells at the opposite pole are almost entirely filled with yolk. These yolk-laden

cells are ultimately invaginated and form endoderm (text figs. XXI to XXIV) and are therefore dorsal in position, while the protoplasmic cells at the opposite pole form ectoderm and are ventral in position. The cells which form the posterior boundary of the yolk-rich hemisphere contain the small spherules, already described, which are characteristic of the yellow protoplasm of *Cynthia*. The distribution of the yolk shows conclusively, therefore, that the cells of the animal or ventral hemisphere contain most of the clear protoplasm and give rise to the ectoderm, while the cells of the vegetal or dorsal hemisphere contain most of the yolk and yellow protoplasm and give rise to the endoderm and mesoderm.









FIGS. XXI–XXIV.—Sections of eggs of *Cynthia partita*; Figs. XXI and XXIV in the median plane, Fig. XXIII a little to one side of the median plane at the posterior end. Fig. XXII in a transverse plane. Fig. XXI represents a 64-cell stage, Fig. XXII a 64-76 cell stage, Fig. XXIII a 76-110-cell stage, and Fig. XXIV a 110-cell stage. The clear protoplasm, the yellow protoplasm and the yolk are represented as in the preceding figures. The clear protoplasm is localized chiefly in the ectoderm and neural plate cells, the yellow protoplasm in the crescent cells (mesoderm) and the yolk in the endoderm and chorda cells; yolk is also present in the inner ends of the ectoderm and mesoderm cells. The polar bodies shown in Fig. XXIII in dotted outline do not lie in the plane of the section drawn, but in that of the next section of the series. It is probable that the neural plate and chorda cells of this figure ($A^{7.4}$ and $A^{7.3}$) have already divided in a transverse plane (*v.* fig. 131), and that these cells should therefore be labelled $A^{7.7}$ and $A^{7.5}$ as in Fig. XXIV. In Fig. XXII the mesoderm cell $B^{7.4}$ (Fig. XVIII) has divided into a mesenchyme cell ($B^{7.3}$) and a muscle cell ($B^{7.4}$), the former containing little and the latter much of the yellow protoplasm.

(2) This orientation is further confirmed by a study of the yellow crescent of the *Cynthia* egg and of the cells which develop from it. As has been shown, the yellow protoplasm of this egg collects at the lower (vegetal) pole and then moves up

to a position just below the equator on the posterior side where it forms a yellow crescent. At the first cleavage this crescent is divided in the middle into right and left halves; at the second cleavage it passes into the two posterior cells of the 4-cell stage; at the third cleavage it goes into the two posterior vegetal cells of the 8-cell stage. In two subsequent divisions the yellow protoplasm is separated from the yolk with which it is associated and thereafter forms a crescent of yellow cells which surrounds the posterior side of the egg just below the equator (figs. 37, 39, 41, 42). At all stages of development this crescent or, the cells which arise from it, lies in the posterior half of the vegetal hemisphere, and the yellow cells are never separated from the mid-dorsal line by more than a single row of yolk cells (figs. 44-48). On the other hand these yellow cells are separated from the mid-ventral line by an ever increasing number of clear protoplasmic cells (figs. 43, 45, 122, 129, 137, *et seq.*). The single row of yolk cells mentioned above as lying between the yellow cells and the dorsal mid-line invaginates during gastrulation and gives rise to the ventral cord of endoderm in the tail of the larva, while the yellow cells, which are also invaginated, give rise to the mesoderm. A study of this yellow crescent and of the cells which develop from it shows conclusively that it always lies on the posterior border of the yolk-rich or dorsal hemisphere, that at the 16-cell and 32-cell stages, it is separated from cells which give rise to the ventral endoderm, and that it is invaginated with the endoderm and forms the muscle cells and mesenchyme of the tadpole.

(3) Wholly similar results as to the orientation of the egg and embryo follow from a study of the lineage of all the other cells of the embryo. I believe that I have seen every division of every cell up to the 218-cell stage, and in the critical period between the 32-cell and 76-cell stages I have seen these divisions in hundreds of cases. The evidence from this source as to the orientation cannot here be presented in detail but must be deferred to that portion of this paper which deals particularly with the cell-lineage; however, it can be said that in not a single instance have I found any evidence against the orientation according to Van Beneden and Julin, while every observation which I have made on the cell-lineage speaks in favor of that orientation.

(4) Finally a most direct and convincing evidence in favor of this system of orientation is found in the position of the polar bodies throughout development. In preparations of the eggs of the three genera of ascidians which I have studied, the polar bodies are easily distinguishable from the test cells by their deeper stain; in *Ciona* they are also larger than the test cells. In the last named genus I have seen the polar bodies attached to the egg or imbedded in it at every stage from the unsegmented egg to the gastrula (Plates XI and XII). In every single instance they have been found at a point on the ectodermal (ventral) hemisphere which a study of the cell-lineage shows to correspond to the animal pole of the unsegmented egg. I have not observed the polar bodies in every egg of *Cynthia* which I have studied or drawn, possibly because they do not in this genus remain attached to the egg so persistently as in *Ciona*, but wherever I have been able to

identify them they have been found at the same pole of the egg as in *Ciona* (figs. 87, 92, 96, 102, 106, 107, 108, 110, 115, 116, 130, 133, 139, 143). In stages later than figures 139 and 143 the protoplasm of the polar cells becomes vesicular and stains so faintly that they can no longer be identified with certainty.

Castle maintained from indirect evidence, as I have already shown, that the polar bodies of *Ciona* are formed at the middle of the endodermal or dorsal half of the egg. I have never in a single instance observed anything which might be mistaken for a polar body at this pole, whereas I have found the most positive and oft repeated evidence that the polar bodies lie at the ectodermal or ventral pole from the time of their formation to the gastrular stage. These ascidians therefore form no exception to the general rule that the polar bodies are formed at the middle of the ectodermal hemisphere of the egg.

It is not necessary in this place to point out in more detail than has been given already the sources of error in the work of Seeliger and of Samassa, especially as their work does not undertake to follow the exact cell-lineage of every cell up to the gastrular stage or later. With Castle's work, however, the case is quite different, for while the considerations already mentioned probably explain the sources of his error of orientation, they do not explain the way in which he has incorporated this error in the cell-lineage which he has followed to an advanced stage. In brief, I find almost all of Castle's figures correctly drawn, and I can without difficulty correlate his drawings cell for cell with my own. The most important exceptions to this statement are found in his figures 53 and 54, but even here the differences are not great. His gastrular stages are of course correctly oriented since the dorsal and ventral faces of the embryo are unmistakably marked out as soon as the invagination begins. All of his pregastrular stages, however, with the exception of a 48-cell and a 64-cell stage, shown in his figures 57 to 60, are erroneously oriented, dorsal being mistaken for ventral and ventral for dorsal. With the lineage which he gives of every cell up to the 46-cell stage (his fig. 56), I entirely agree, but in passing to the 48-cell stage (his figs. 57 and 58) he inverts the egg and shifts the equator one cell-row nearer the vegetal pole than it should be, consequently all of the lineage of the later stages is wrong. While therefore the stages from 48 cells on are correctly orientated, the lineage of the individual cells is incorrect; before the 48-cell stage the lineage is correct but the orientation wrong. The evidence for this grows in part out of the general considerations already mentioned, but it is also founded upon a detailed study of the cell-lineage, to which we now turn.

IV. CELL-LINEAGE.

A. Nomenclature.—In order to facilitate reference to the work of others, it is desirable that some good system of naming the individual cleavage cells be adopted and thereafter adhered to even if it be not ideally perfect. The system which has been employed with only slight modifications in all the recent cell-lineage work on annelids and mollusks is not well suited to the ascidian egg because in

the latter there is no distinction of macromeres and micromeres, because there are no "quartets" which arise from stem cells, because this system is not well adapted to show the perfect bilateral symmetry of the egg and embryo, which is one of the most characteristic features of ascidian development, and finally because of the great number of figures which must be used as exponents in the representation of later stages (*e g*. the letter designating each of the cleavage cells of the ninth generation, figs. 140–143, would need to be followed by no less than six exponents). Owing to these reasons I early saw the difficulty of attempting to apply this system to the cell-lineage of the ascidian egg. The most complete system of nomenclature which has heretofore been used in the study of the cell-lineage of ascidians is that of Castle, which is a modification of a system devised by Kofoid (1894). In this system, as is well known, the four quadrants of the egg are designated by the letters A, B, C, D; after the third cleavage the cells nearer the vegetal pole are designated by capitals, those near the animal pole by lower case letters. The first exponent following a letter indicates the generation to which a cell belongs, the second exponent the position of the cell relative to the vegetal pole. With this system it is always difficult to determine at a glance the lineage of any cell since "to ascertain the mother cell of any particular cell, its first exponent must be diminished by one; and its second exponent, if an even number, must be divided by two, but if an odd number it must be first increased by one and then divided by two. In order to determine the daughter cell of a particular cell, simply reverse this process; that is, increase the first exponent by one and double the second exponent. To determine the other daughter cell diminish this second exponent by one" (Castle, 1896, p. 227). While it is thus difficult to determine at a glance the lineage of any cell, the number of exponents required is relatively small, and this fact, more than any other, has led me to adopt Castle's system, with the following modifications:—The right and left halves of the embryo are designated by the same letters, the names of cells on the right being underscored as compared with those on the left. This method of designating the cells of the right and left sides is essentially similar to that employed by Chabry (1887). In this way but two letters are needed for the whole cell-lineage, one for the anterior and another for the posterior quadrants. For these I desired to use the letters employed by Van Beneden and Julin and by Chabry, *viz*. A and P, but owing to the difficulty of distinguishing between lower case and capital P, I finally chose the letter B instead of P. The right anterior quadrant is A, the left A; the right posterior quadrant is B, the left B. After the third cleavage all cells lying on the polar body side of that cleavage plane are designated by lower case letters, while those on the opposite side of that plane continue to be designated by capitals. This modification not only emphasizes the bilateral character of the ascidian egg, but it also simplifies the nomenclature. Furthermore, it facilitates reference to Castle's work, for when in his orientation of the 48-cell stage the egg is inverted as compared with earlier stages the right side is substituted for the left, and the letters A and D, which in the earlier stages designate the actual left side, are used after the

48-cell stage to designate the actual right and *vice versa*. In my modification of his system this substitution of one side for the other will be indicated only by the presence or absence of a line under the letter. In all stages later than the 48-cell stage I continue to use lower case letters to designate cells of the animal or ectodermal hemisphere, and capitals for those of the opposite hemisphere, whereas Castle reverses this rule.

B. Cleavage of the Egg; First to Seventh Generation of Cells (1–64 Cells).

Although the details of the early cleavages of the ascidian egg have been treated at considerable length by previous writers on this subject, I have determined to present the subject here, cleavage by cleavage, both because my results differ in many respects from the conclusions heretofore reached and because I wish to call attention to certain features of these cleavages which have not as yet been noticed. I shall shorten the account wherever possible by references to previous work.

As is well known, ascidian eggs develop with great rapidity; there are certainly few other eggs which develop so rapidly. Both *Ciona* and *Cynthia* reach the fully formed tadpole stage in about twelve hours, while *Molgula* reaches this stage in not more than eight hours after fertilization. Certainly there are few things more wonderful than the origin of a complex animal,—of a chordate—, from an egg in the short space of from eight to twelve hours! The portions of this brief period devoted to the different stages of development are interesting and suggestive. In *Cynthia* about 40 minutes elapse between the fertilization and the appearance of the first cleavage furrow; about 140 minutes between the first cleavage and the beginning of gastrulation; and about 140 minutes between this stage and the young tadpole stage shown in figure 163. The different generations of cleavage cells are separated from one another by intervals about as follows:[1]

Fertilization to first cleavage	(1–2 Cells), . .	40 min.
First to second cleavage	(2–4 "), . .	30 "
Second to third cleavage	(4–8 "), . .	30 "
Third to fourth cleavage	(8–16 "), . .	20 "
Fourth to fifth cleavage	(16–32 "), . .	20 "
Fifth to sixth cleavage	(32–64 "), . .	20 "
Sixth to seventh cleavage	(64–112 "), . .	20 "
Seventh to eighth cleavage	(112–218 "), . .	20 "
Eighth cleavage to young tadpole stage (fig. 163),	.	2 hrs.

1. *First Cleavage; 1–2 cells.* (Figs. 18–27, 96–100, 177, 178, 181.)

After the meeting of the germ nuclei, which occurs about midway between the center of the egg and the posterior pole (figs. 91, 92, 93), the cleavage spindle develops rapidly and moves inward from the posterior pole until it lies almost

[1] These figures are based upon the study of eggs laid and fertilized at 5 P.M. and put up at intervals thereafter until 11 P.M. In each of these lots eggs were found in several different stages and the results can be accepted as only approximately correct.

exactly in the center of the egg (fig. 96), always being oriented so that it lies at right angles to the plane of the first cleavage and with its equator in that plane. At the same time the clear protoplasm and a small portion of the yellow protoplasm move inward from the posterior pole toward the center of the egg (figs. 92, 96). The larger part of the yellow protoplasm remains at the surface in the form of a crescent, but the clear protoplasm is entirely withdrawn from the surface except for a narrow zone which lies just above (ventral to) the crescent on the posterior side (figs. 13–18, 96). During the formation of the first cleavage furrow, even this narrow zone of clear protoplasm is withdrawn from the surface to the center of the egg, so that the yolk now covers the entire surface of the egg except for the area of the crescent (figs. 100–102 and 178–179). This condition is just the reverse of that which prevailed at the beginning of development, when the yolk was central in position and the protoplasm peripheral (figs. 76–79).

The centrosomes and asters are larger and more easily studied in *Ciona* than in *Cynthia*. Proceeding from the periphery to the center, the following parts of the aster may be recognized (figs. 177, 179) : (1) The deeply staining, peripheral layer of the aster, (2) the clear inner layer of the aster traversed by radiating fibres, (3) a granular central body upon which the astral fibres end. The latter is the centrosome, and is plainly composed of two parts, (*a*) an outer granular zone and (*b*) a central clear area from which the netrum arises. In *Cynthia* the outer and inner layers of the aster are not distinguishable and the centrosome itself is not so large as in *Ciona;* the latter is, however, composed of the same parts, *viz.*, a peripheral granular zone and a central clear area which gives rise to the netrum (figs. 98, 99). In these ascidians, just as in the gasteropods which I have studied (Conklin, 1902), the centrosome undergoes a decided growth and metamorphosis during the cycle of division; in the early stages of the cycle it is a small, deeply staining body, in the later stages it becomes much larger and differentiates into the outer granular zone and the central clear area (*cf.* figs. 97, 98).

In *Ciona* both the first and second cleavage spindles are remarkable in that at all stages of the division the nuclear part of the spindle can be clearly distinguished from the polar or astral part (figs. 177, 179). The portion of the spindle derived from the linin of the germ nuclei is short, deeply staining and barrel-shaped, and in all respects resembles a maturation spindle (compare figs. 177 and 179 with figs. 67, 70, 71). Even in the possession of a few peripheral fibres which radiate from the slightly rounded ends of the spindle toward the equator, this spindle resembles those of the maturation divisions. These peripheral fibres are not in line with the astral radiations, and hence are all the more striking. The astral rays which run from the centrosomes to the ends of this nuclear spindle are small and faintly staining as contrasted with the heavy, deeply staining fibres of the nuclear spindle. Nowhere else, so far as I am aware, is this double character of the mitotic figure so clearly shown as in these cleavages of *Ciona*. This is due to the small size of the nuclear spindle and to the large size of the astral systems, so that the ends of the nuclear spindle are not easily confused with the astral rays, and also to the great

difference in the staining reactions of the two. Except for the presence of these astral systems, this cleavage spindle is almost exactly like a maturation spindle.

In *Cynthia* the distinction between these two parts of the cleavage spindle is not so clear because here the nuclear portion is much longer and reaches nearly to the centrosomes (fig. 97); but even here the nuclear part can be distinguished from the astral by the stronger character of its fibres. In this genus also the astral systems are not so large as in *Ciona* and the individual fibres are stronger, so that the contrast between the nuclear and the astral portions of the spindle are but faintly marked.

These cleavage spindles of *Ciona*, like the maturation spindles already described, are of especial interest for the study of the mechanics of mitosis. I have not attempted to make a detailed study of this subject, but it is quite evident that the separating chromosomes move only as far as the ends of the nuclear spindle fibres (fig. 99). They are never drawn up into contact with the centrosomes, but remain at the border of the aster, where they are transformed into chromosomal vesicles. In the maturation divisions there are no centrosomes or asters at all to complicate the problem, and here also the chromosomes move only to the ends of the nuclear spindle fibres. These fibres elongate somewhat in the later stages of mitosis (figs. 70, 71, 72), thus separating more widely the daughter chromosomes.

The fact that in the maturation divisions the chromosomes separate without the aid of centrosomes or asters may be taken as evidence that in the similar spindles of the first and second cleavages the centrosomes and asters, although present, take no part in this work. Anything which will explain the movements of the chromosomes in such spindles as those shown in figures 69 to 72 will also explain their movements in such cleavage spindles as those shown in figures 177 and 179. In the maturation mitoses there are neither centrosomes nor asters, and yet the separation of the chromosomes occurs in the usual manner. The spindle fibres apparently serve only as a guide for this movement, and must be considered the result rather than the cause of stresses in the cell substance. This is shown by the fact that when they first appear these spindle fibres are not parallel but run in all directions (figs. 62, 64). Later, under the influence of stresses in the cytoplasm, they become parallel. Under these circumstances there is no reason to believe that the movement of the chromosomes is caused by other factors than those which bring about movements in the cell body.

The constriction of the cell body first occurs, as indicated by figure 20, at the posterior pole. This is probably due, as Castle says, to the fact that at this stage this pole is the more richly protoplasmic one. Very soon the constriction extends all the way around the egg and, as the mitotic spindle lies in the middle, it follows that the constriction must be about as deep on one side as on another (fig. 99). This constriction divides the oöplasm with exact equality, not only quantitatively but qualitatively also. During and immediately following this division the yellow crescent undergoes some very remarkable transformations. These changes are shown in figures 21 to 26, which represent consecutive stages of the same egg drawn

at intervals of about two or three minutes. The crescent is first constricted in the middle (figs. 20 and 21); then the gray yolk penetrates into the lower part of each half of the crescent and approaches near to the surface, being covered only by a thin layer of the yellow protoplasm (fig. 22). Above and below this intrusion of yolk the crescent remains deep yellow in color; in the region of the intrusion the color is gray with a superficial covering of yellow pigment granules. The lower (dorsal) portion of the crescent thus cut off from the remainder is small as compared with the upper part, and is median in position. Not more than two minutes afterward this lower part unites with the upper along the median line (fig. 23), thus forming a deep yellow semicircle in each blastomere. The intrusion of yolk may still be seen entering this semicircle through its open half, which is dorsal and lateral in position. Then these two semicircles come into contact with each other along the first cleavage plane, the free ends enlarge into rounded knobs, and the intrusion of yolk is less large (fig. 24). Finally, the intrusion becomes still smaller, the open ends of each semicircle join, and the crescent is reestablished (figs. 25 and 26). Observation of the living egg during this period of division gives the impression of remarkable cytokenetic activity in all the oöplasm; not only does the crescent take part in this activity but the yolk and the clear protoplasm undergo marked movements, in the course of which the clear protoplasm is divided into two areas which are entirely separated from each other by a partition of yolk (figs. 25–27). I have been unable to analyze all of these movements; one thing, however, seems very probable, *viz.*, that they are in the main of a vortical nature and that they are comparable with the movements in the constriction of the cell body which I have observed in gastropods (Conklin, 1902). I have not thoroughly studied these movements by the aid of serial sections; since they take place with such rapidity, this would be possible only by sectioning and studying a very large number of eggs during the period of the first cleavage. In figure 99, which is an equatorial section of an egg of the stage shown in figure 22 or 23, the substance of the crescent (Cr) can be recognized on the posterior side of the egg; it does not, however, show any of the thickenings or thinnings indicated in the surface views mentioned. Beneath the superficial layer of yellow protoplasm in this figure is an area of clear alveolar protoplasm, while still deeper is the radiating protoplasm which constitutes the astral systems.

In the telophase of the first cleavage the centrosomes, daughter nuclei, and the surrounding areas of clear protoplasm rotate toward the animal pole (fig. 100) in a manner similar to that which occurs in the blastomeres of gasteropods (Conklin, 1902). Through the agency of these telokinetic movements of the first cleavage the nuclei, centrosomes and clear protoplasm are carried above the equator of the egg toward the animal pole. The pole at which the polar bodies lie thus becomes more richly protoplasmic than the opposite pole and ever after continues to be so (fig. 102, *et seq.*). Castle has observed this telokinetic movement in *Ciona*, and describes it in the following words (1896, p. 233): "The first cleavage spindle arises, as has been stated, not far from the center of the egg. As its first cleavage is nearing completion, however,

the attraction spheres and nuclei begin to move toward the dorsal surface of the egg, *away from* its more richly protoplasmic animal pole, from which the plane of separation cuts it more rapidly." I find, however, that in *Ciona*, as in *Cynthia*, this telokinetic movement of the nuclei and spheres is not away from the more richly protoplasmic pole, unless the substance of the crescent be considered as constituting the protoplasmic pole, but that the clear protoplasm also moves with the nuclei and spheres toward the animal (ventral) pole (figs. 178, 182). Sobotta (1897) has also observed a similar bending of the spindle axis and movement of the daughter nuclei and centrosomes in the anaphase or telophase of the first cleavage of the egg of *Amphioxus*. He describes it as an attempt on the part of the centrosomes and nuclei to regain the center of the blastomeres; but it is probable that this is only another case of the telokinetic rotation of the cell contents with the consequent establishment of a new cell axis (*cf.* Conklin, 1902).

2. *Second Cleavage; 2–4 cells.* (Figs. 28–30, 101–105, 179, 182, 183).

During the anaphase of the first cleavage each centrosome becomes elongated at right angles to the spindle axis and to the chief axis of the egg and gives rise to a minute centrosomal spindle or netrum at each pole of the mitotic figure (figs. 98, 99). These netra elongate in the antero-posterior axis until the daughter centrosomes come to lie at the anterior and posterior poles of the nucleus of each blastomere; the nuclear membrane is then dissolved and the second cleavage spindles are formed (figs. 101, 102, 177, 179). These spindles, like those of the first cleavage, are composed of a nuclear and an astral portion, the two being distinguishable with especial ease in *Ciona* (fig. 179). The spindles lie in an area of clear protoplasm above the equator of the egg, and in *Cynthia* are slightly eccentric toward the posterior pole (fig. 102). The areas of clear protoplasm become elongated in the antero-posterior axis (figs. 28, 101, 102, 179); they are surrounded on all sides by yolk, which forms a peripheral layer over the whole surface of the egg, except in the region of the crescent. The substance of the crescent is directly continuous with the clear protoplasm in the region of the posterior pole of the second cleavage spindle (figs. 102, 179). Although the yolk surrounds the areas of clear protoplasm it is not uniformly thick on all sides; on the upper or ventral side of these areas the layer of yolk is very thin, on the lower or dorsal side and anterior to the crescent it is especially thick. This distribution of the yolk can be seen not only in sections, such as figures 102 and 179, but also in entire preparation and in living eggs. In the latter the light gray of the upper hemisphere (figs. 28, 29 and 30), as contrasted with the dark gray of the lower hemisphere, indicates that the layer of yolk which surrounds the areas of clear protoplasm is thin over the upper hemisphere and thick over the lower. The area at the vegetal pole, where the layer of yolk is thickest, gives rise to the endoderm cells which are always yolk laden; the upper hemisphere, where the yolk layer is thin, gives rise to the ectoderm cells which contain a relatively small amount of yolk; the substance of the crescent gives rise to the muscle and mesenchyme cells, and in *Cynthia* is always characterized by the presence of the yellow spherules. In later

stages the yolk ceases to be peripheral in position and comes to lie in the central portions of the cleavage cells (text figs. XVII–XXIV); this change in position is brought about by the flowing of the peripheral layer of yolk inward along all the developing cleavage furrows (figs. 104–107, *et seq.*) until finally the yolk comes to occupy a central position in all the blastomeres, while the clear protoplasm is brought once more to the surface. These cytokinetic movements which accompany cell division do not change the relative distribution of yolk and cytoplasm in the different hemispheres and quadrants of the egg, but only its location in the individual cleavage cells.

In the second cleavage the constriction of the cell begins at the periphery or free surface and proceeds inward through the cell body (figs. 104, 105). The peripheral layer of yolk is thus carried inward along the cleavage furrow, as has been said, and the middle of each spindle is bent in toward the center of the egg (fig. 105). At the same time the yolk and yellow protoplasm continue to be carried in along the first cleavage furrow. The inflow of yolk along a developing cleavage furrow leaves a protoplasmic connection between the two daughter cells, into which the yolk does not penetrate for a considerable time; this protoplasmic connection is frequently of service in determining the lineage of cells since it always connects daughter cells (figs. 104–107). Finally the inflow of yolk completely cuts off this connection.

The four cells which are formed by the second cleavage are all approximately of the same size in *Ciona;* in *Cynthia* the two anterior cells are slightly larger than the posterior ones, just as Van Beneden and Julin found to be the case in *Clavellina* (text figs. VII, VIII). But though the daughter cells are of nearly the same size they are of very different quality. The posterior cells contain about the same quantity of clear protoplasm as the anterior ones, but they contain little yolk and practically all of the yellow crescent substance; the anterior cells on the other hand contain a great deal of yolk, but practically none of the crescent substance. The second cleavage is therefore differential in a very marked degree (*cf.* figs. 29 and 30).

3. *Third Cleavage; 4–8 cells.* (Figs. 31–35, 106–109, 184).

In the anaphase of the second cleavage the centrosomes elongate in the vertical axis and the daughter centrosomes, moving to the upper and lower poles of the nuclei, form the centrosomes of the third cleavage spindles. In an abnormal egg shown in figure 103 this division of the centrosomes occurs in one of the blastomeres in the prophase of the second cleavage and not in a vertical but in a horizontal direction. The position of these third cleavage spindles is peculiar and of great prospective significance. They are slightly eccentric toward the animal pole, and accordingly the four cells which are cut off at this pole are smaller than those at the vegetal pole. When the egg is viewed from either the right or the left side the spindles in the anterior and posterior quadrants seem to be parallel and are both slanted forward at the upper pole; accordingly the four upper cells, when formed, lie slightly anterior to the four lower ones (figs. 108, 184). When the egg is viewed from the

anterior pole it is seen that the spindles in the anterior quadrants are not parallel, but that they converge toward the animal pole. The reverse is the case if the egg is viewed from the posterior pole, *i. e.*, the spindles in the posterior quadrants diverge toward the animal pole. Thus it comes about that the nuclei in the anterior-vegetal cells ($A^{4.1}$) are relatively far apart, those in the anterior-animal cells ($a^{4.2}$) close together (figs. 106 and 109); whereas the reverse is the case in the posterior cells, *i. e.*, the nuclei in the posterior-vegetal cells ($B^{4.1}$) are near together, those in the posterior-animal cells ($b^{4.2}$) far apart (fig. 107).[1]

Every one of these matters is of prospective significance in the further development of the embryo; associated with the forward slant of the spindles toward the animal pole is the fact that the cells of the animal hemisphere overhang those of the vegetal hemisphere at the anterior pole; whereas the posterior cells of the vegetal hemisphere are not completely covered by those of the animal hemisphere when the egg is viewed exactly from the animal pole (figs. 110, 112, 116). Associated with the convergence of the spindles in the anterior quadrants toward the animal pole and the convergence of the spindles of the posterior quadrants toward the vegetal pole is the fact that in later stages the anterior half of the vegetal hemisphere is broad from side to side, its posterior half narrow, while the anterior half of the animal hemisphere is narrow from left to right, its posterior half broad (figs. 109–118, *et seq.*). While the position of these spindles is therefore indicative of important prospective characteristics of the embryo, it must not be regarded as the initial cause of these characteristics. Indications of these features may be seen in the distribution of the yolk and protoplasm at the four-cell stage, and there can be no doubt that the position of the spindles is itself the result of cytoplasmic localization.

One of the features of this stage to which Castle calls particular attention is the presence of a "cross-furrow" on the right and left sides between the anterior dorsal and the posterior ventral cells ($A^{4.1}$ and $b^{4.2}$, figs. 31, 32, 108, 184). I find, as did Castle and Chabry, that this cross-furrow is constant in position and that it marks a downward bend in the equator, which may be observed as late as the gastrula stage; in the region of this downward bend the ectoderm cells grow down over the cells of the vegetal hemisphere in advance of the neighboring ectoderm cells (figs. 116–119, 123–126, 128, 130, 134, *et seq.*). I observed the process of formation of this cross-furrow in the living egg, and have represented this in figure 31. When the third cleavage furrows first appear, they are all in nearly the same plane, the furrows between the daughter cells of the posterior quadrants being nearly perpendicular to the egg axis, as indicated by the faint line between the cells $B^{4.1}$ and $b^{4.2}$ of figure 31, which line represents the position of the furrow between those cells when it first appears. A minute or two afterward this furrow is tilted downward at its anterior end and upward at its posterior, as indicated by the heavy line between those two cells; in this way the cross-furrow arises on the right and left sides of the egg between the anterior dorsal and the posterior ventral cells.

[1] Figs. 106 and 107 represent two sections of one and the same egg, in the 8-cell stage, the former through the nuclei of the anterior cells, the latter through the nuclei of the posterior ones.

During telokinesis the movements in the cell body are similar to those which occur at the close of the second cleavage, *i. e.*, the middle of the spindle is carried in toward the centre of the egg while the poles of the spindle move outward toward the surface (figs. 106, 107). By this movement the spindle axis is much bent on itself. I have not observed in these eggs any tendency for the sphere substance at the poles of the spindles to be carried as near as possible to the animal pole,—a thing which is very apparent in gasteropod eggs.

I have already called attention to the fact that the four cells at the animal pole are smaller than those at the vegetal pole; this disparity is most marked between the upper and lower cells of the anterior quadrants (figs. 106, 107). The anterior dorsal cells ($A^{4.1}$) are the largest in the egg at the eight-cell stage, the anterior ventral cells ($a^{4.2}$) the smallest. The posterior dorsal cells ($B^{4.1}$) are but little, if any, larger than the posterior ventral ones ($b^{4.2}$), and both are intermediate in size between the upper and lower anterior cells.

The different cell substances are distributed to the eight cells as follows: The clear protoplasm is found in all the cells, but is most abundant in the four ventral cells and least abundant in the two posterior dorsal cells ($B^{4.1}$); yolk is found in all of the cells, but is most abundant in the two anterior dorsal cells ($A^{4.1}$) and least abundant in the four ventral cells; the yellow protoplasm or crescent substance is confined almost entirely to the two posterior dorsal cells ($B^{4.1}$), but a very small amount of it is found around the nuclei of all the cells (figs. 106, 107, Cr. s.). My attention was first drawn to the yellow protoplasm around the nuclei in my study of the living eggs of *Cynthia* (figs. 32–40, *et seq.*); since then I have found, in preserved material, a few of the spherules of this yellow protoplasm around the first cleavage spindle and around the resting nuclei of the 2-cell, 4-cell and 8-cell stages (figs. 96, 106, 107). In later stages of development it is found around the nuclei of a few of the ectoderm cells even as late as the young tadpole stage (plates IV and V). In spite of this perinuclear distribution of some of this crescent substance, it is largely limited to the two posterior dorsal cells ($B^{4.1}$) of the 8-cell stage, where it constitutes more than half of all the substance of those cells (figs. 31–35, 106, 107).

Van Beneden and Julin first observed that the four ventral cells of the 8-cell stage are smaller than the four dorsal ones; Seeliger, Samassa, and Castle observed this same fact, though they incorrectly called these smaller cells dorsal in position. Castle is quite right when he says (1896, p. 228) the "four cells which lie nearest the polar globules are smaller than those more remote," but I cannot understand how it was possible for him to reach the conclusion that the smaller cells "are more abundantly supplied with yolk," while the larger cells are richer in protoplasm (pp. 234 and 235). According to my observations this is not true of *Ciona*, *Cynthia* or *Molgula*.

During the 8-cell stage two little bosses or caps of clear but deeply staining protoplasm which will give rise at the 64-cell stage to the small posterior mesenchyme cells ($B^{7.6}$ fig. 130 *et seq.*) are visible on the posterior surface of the cells $B^{4.1}$ and $B^{4.1}$ (fig. 184). These little caps lie in contact with each other on each side of

the mid-line and right at the middle of the crescent, of which they form an extremely small part. They are formed by the aggregation at this point of a little clear protoplasm which first appeared at the time of fertilization as a clear area around the spermatozoon, and which afterwards lies at the middle of the crescent (figs. 173, 175, 176). In *Cynthia* this area of clear protoplasm does not usually take the form of the deeply staining bosses or caps before the 16-cell stage (figs. 113, 115), though these may sometimes appear, as they do in *Ciona*, at the 8-cell stage. Although they arise from the surface of the crescent they contain no yellow pigment, and in the living egg this small spot of protoplasm and the cells to which it gives rise are almost perfectly transparent and are therefore difficult to see. In stained preparations they always stain deeply and thus form an excellent landmark (figs. 116–120, *et seq.*).

Chabry and Castle have called particular attention to these prominences of clear protoplasm which are found at the posterior pole of the egg, and Castle traces them back to the 2-cell stage, and gives good reason for believing that this area of clear protoplasm marks the point of entrance of the spermatozoon, and was caused by it. I entirely agree with Castle that this aggregation of clear protoplasm is caused by the entering spermatozoon, since I have seen it surrounding the spermatozoon immediately after its entrance (fig. 173); but it can scarcely be said to mark the point of entrance, as it does not remain stationary but moves with the crescent from a point near the vegetal pole to one near the equator on the posterior side of the egg. So far as I am able to determine from a study of Castle's figures and description, the area of finely granular protoplasm, which he represents in his figures 17, 45, 46 and 47, is the middle portion of the crescent. The large area of clear protoplasm represented in each of these figures and marked x gives rise to the middle cells of the crescent ($C^{5.2}$, $D^{5.2}$ of his fig. 49), therefore the small posterior mesenchyme cells, $C^{7.5}$ and $D^{7.5}$ of later stages, can represent but a small part of the area marked x in the earlier stages. The earliest stage in which Castle represents the substance of these future mesenchyme cells is at the posterior pole of the cells $C^{6.3}$ and $D^{6.3}$ in his figure 51. I conclude, therefore, that he observed the middle portion of the crescent (x of his figures) in the earliest stages of the development, but that he did not recognize the substance of the small mesenchyme cells as distinguished from the substance x (crescent substance) before the 24-cell stage (his fig. 51).

All students of ascidian embryology agree that the first plane of cleavage is median in position, the second transverse, and the third horizontal or coronal, but beyond this there are few agreements among them, as has been pointed out. In the matter of the relations of these cleavage planes to the germ layers there are as many opinions as there are concerning the orientation of the egg. Van Beneden and Julin (1884) maintained that the four ventral cells of the 8-cell stage are purely ectodermal, but that the four dorsal cells are still "mixed," each of them containing ectoderm and endoderm, while not until the 44-cell stage is the separation of ectoderm and endoderm in these dorsal cells completed. Seeliger (1885) held

that the third cleavage plane separates the ectoderm from the endoderm, the four ventral cells being ectodermal, the four dorsal endodermal. Davidoff (1891) found that in *Distaplia* the four ventral cells are ectodermal, the four dorsal endodermal, and a similar view is maintained by Samassa (1894). Castle (1896), on the other hand, maintains that both the ventral and the dorsal cells of the 8-cell stage are mixed, the ventral cells containing ectoderm and mesoderm, and the dorsal cells endoderm and mesoderm, and not until the 48-cell stage are the substances of these layers finally separated.

My work, like that of Castle, places but little weight upon the idea of germ layers, since it undertakes to trace specific organs to certain cleavage cells, and even to certain regions of the unsegmented egg. Emphasis is therefore placed upon organs and upon organ-forming cells and substances rather than upon the more indefinite germ layers. However, I find that the four ventral cells of the 8-cell stage are purely ectodermal, while the four dorsal cells are endodermal and mesodermal, save for the fact that four neural plate cells ($A^{7.4}$, $A^{7.8}$, figs. 120, 121, 123) will arise from the anterior portion of the dorsal hemisphere at the 44-cell stage. The mesoderm and endoderm are first completely separated at the 22-cell stage (figs. 117, 118). I find that only four ectodermal (neural plate) cells come from the dorsal hemisphere, whereas Van Beneden and Julin hold that at a corresponding stage (44-cells), sixteen ectodermal cells have been derived from the dorsal hemisphere. Of these sixteen cells four only are really ectodermal (the neural plate cells), eight are mesodermal, and four are endodermal. Castle's conclusion that a portion of the mesoderm is derived from the ventral cells is due to his erroneous lineage of the cells after the 48-cell stage; all of the ventral cells are ectodermal, and all of the mesoderm and endoderm are derived from the dorsal cells. With the exception therefore of these four neural plate cells, which arise at the 44-cell stage on the dorsal side of the third cleavage plane, all of the ectoderm lies on the ventral side of that plane, and all of the endoderm and mesoderm on its dorsal side. This conclusion, it will be observed, is very similar to that of Seeliger, Davidoff, and Samassa.

4. *Fourth Cleavage; 8–16 cells.* (Figs. 36–38, 110–115, 186–188.)

The spindles for the fourth cleavage appear in all of the eight cells at about the same time, though the dorsal cells sometimes divide slightly in advance of the ventral ones. All the spindles are approximately horizontal in position, and all are oblique to the median and transverse planes (first and second cleavage planes). As a result of the fact, stated on page 45, that the dorsal hemisphere is broad in front and narrow behind, while the ventral hemisphere is broad behind and narrow in front, we find that the obliquity of the spindles of one hemisphere is reversed as compared with that of the other. Thus the spindles in the anterior-dorsal cells approach in direction a transverse plane, in the posterior-dorsal cells they approach an antero-posterior plane; whereas in the anterior-ventral cells they approach an antero-posterior plane, while in the posterior-ventral cells they approach a transverse plane (figs. 110–113, 186, 187).

Corresponding with these positions of the spindles the subsequent divisions of the cells are such as to lead to an inverse position of the cleavage cells in the dorsal as compared with the ventral hemisphere. In the anterior-dorsal cells the fourth cleavage furrows run from the anterior border of the cells to the transverse (second cleavage) plane, and are approximately antero-posterior in direction; in the posterior-dorsal cells these cleavage furrows run from the lateral borders of the cells to the median (first cleavage) plane and are approximately transverse in direction. In the ventral hemisphere the reverse is the case; in the anterior-ventral cells the fourth cleavage furrows are approximately transverse in direction, in the posterior-ventral cells approximately antero-posterior. Thus it comes about that two of the anterior-dorsal cells do not reach the mid-line, while all of the posterior-dorsal cells do; and that two of the posterior-ventral cells do not reach the mid-line, while all of the anterior-ventral ones do.

The fact that each hemisphere is thus the mirrored image of the other with respect not only to the width of the anterior and posterior parts, but also as to the direction of the fourth cleavage spindles and in the positions of the resulting cleavage cells,—this fact has contributed to the difficulties which most students of ascidian embryology have experienced in distinguishing the dorsal and ventral hemispheres, and has probably been responsible in some cases for the confusion of those hemispheres. However, at this stage as at every other, the two hemispheres are easily distinguished by the relative amounts of yolk and protoplasm at the two poles as well as by the position of the crescent and of the polar bodies.

All of the cell divisions of this cleavage are approximately equal, except that of the posterior-dorsal cells, $B^{4.1}$ and $\underline{B}^{4.1}$. These cells divide very unequally, giving rise to two small posterior cells, $B^{5.2}$ and $\underline{B}^{5.2}$, which are the smallest in the entire egg (figs. 111, 113, 186). Since the work of Van Beneden and Julin, these cells have been observed by all who have studied the ascidian cleavage, and they have served as the most important landmark in the orientation of the cleavage stages.

In this stage as in the preceding one, the yolk is most abundant in the cells of the dorsal hemisphere; the protoplasm, in those of the ventral hemisphere; while the yellow protoplasm is almost entirely confined to the posterior cells of the dorsal hemisphere (figs. 36, 37, 38). In stained preparations the limits of the yolk and protoplasm are sharp and distinct, and are represented in the drawings by a crenated line (figs. 108, *et seq.*). The relative amounts of yolk and protoplasm at the two poles can be readily seen by comparing figure 110 with 111, and 112 with 113. The yolk and protoplasm of the four ventral cells are about equally distributed to their eight daughter cells; the same is true of the two anterior-dorsal cells, which divide so that each of their four daughter cells contains about the same proportion of yolk and protoplasm ($A^{5.1}$, $A^{5.2}$, figs. 36, 37, 113). However, in the division of the posterior-dorsal cells, the daughter cells are qualitatively very disimilar; the small posterior cells ($B^{5.2}$) consist almost entirely of yellow protoplasm, while their larger sister cells ($B^{5.1}$) are about half and half, yellow protoplasm and yolk. The outlines of the yellow protoplasm or crescent are perfectly distinct as shown in

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figure 37, and the formation of the small posterior cells shows most beautifully that the cleavage planes do not necessarily follow the lines of demarcation between the yellow protoplasm and the yolk; for in this case they cut across those lines so that the small posterior cells contain a wedge of yolk in addition to the yellow protoplasm (figs. 37, 113, 117). This yolk is later obscured by being covered by the yellow protoplasm (fig. 39, *et seq.*), but when the posterior cells are first formed it is quite distinct. These small posterior cells contain not only yellow protoplasm and yolk, but also those caps of clear superficial protoplasm which later go into the small posterior mesenchyme cells. These cannot be seen in the living egg, but are very evident in stained preparations (figs. 113, 115, 186, 187).

The localization of yolk and protoplasm at the vegetal pole is now practically the same as at the beginning of gastrulation, and it is clearly indicative of the location of definitive organs. The relative positions of the yolk and yellow protoplasm are the same in the 16-cell stage shown in figure 37, as in the early gastrula stage shown in figure 46. The area of yolk, free from protoplasm, which surrounds the vegetal pole (figs. 37, 111, 113), gives rise to the endoderm of the gastrula, the tongue of yolk which runs back between the arms of the crescent (figs. 37, 113) gives rise to the caudal endoderm cord of the larva, while the greater breadth of the yolk in front of the second cleavage plane (fig. 37, 113) is indicative of the great transverse extent of the endoderm of this region in later stages (fig. 46, *et seq.*). The protoplasm of the anterior-dorsal cells is located at the anterior borders of those cells (figs. 37, 113), and in this region the notochord and neural plate cells later arise. In all these respects the localization of these substances is of direct prospective significance; in fact one may go further and say that *all the regions of the gastrula and certain important organs of the later larval stage are here actually marked out on the egg at the 16-cell stage. This is no ideal mapping out of the egg into organ forming germ regions, but an actual localization of strikingly different substances which need only to be followed through the development to prove that they give rise to definite organs which occupy the same relative positions in the larva, and are composed of the same peculiar substances, as in the early cleavage stages or even in the unsegmented egg.*

5. *Fifth Cleavage; 16–32 cells.* (Figs. 39–42, 116–119, 189–195).

The fifth cleavage does not occur simultaneously in all the cells of the fifth generation, but divisions appear in the cells of the vegetal or dorsal hemisphere before they do in those of the animal or ventral hemisphere (figs. 116–118, 189, 190). In *Cynthia* the anterior-dorsal cells divide a little earlier than the posterior-dorsal ones (fig. 117), and the anterior-ventral cells a little in advance of the posterior-ventral ones (fig. 118). In *Ciona,* also, the cells of the dorsal hemisphere divide before those of the ventral, but there is practically no difference in the time of division of the anterior and posterior cells of this hemisphere. Neither at this stage nor at any preceding or succeeding one are the cleavages more rapid or the cells more numerous at the posterior than at the anterior pole, as claimed by Van

Beneden and Julin for *Clavellina* (1884, p. 13). Although this cleavage may be subdivided into 20-cell, 22-cell and 24-cell stages, the duration of each of these stages is very brief, and the fifth cleavage is completed in all the cells before the sixth appears.

Castle (1896, p. 229), in particular, has described the differences in the time of division of the cells of the dorsal and ventral hemispheres, and has made it a principal evidence in favor of his scheme of orientation. The fact that at this and at the succeeding cleavage the cells of one hemisphere divide earlier than those of the other has been accepted by him as proof that the earlier dividing hemisphere is ventral and ectodermal, while the more slowly dividing one is dorsal and endodermal, since, at the time of gastrulation, the number of cells of the ectodermal hemisphere is greater than that of the endodermal. But neither the fifth nor the sixth cleavage results in the formation of more cells in one hemisphere than in the other, since all the cells of both hemispheres divide before the next cleavage begins; at the close of the fifth cleavage there are sixteen cells in each hemisphere, and at the close of the sixth cleavage thirty-two cells in each hemisphere. In the seventh cleavage, as we shall see, the hemisphere in which divisions were slower at the two preceding cleavages becomes the more rapidly dividing one, and thereafter the number of cells is more numerous in this hemisphere than in the opposite one.

In the anterior-dorsal cells the fifth cleavage spindles are parallel with the median plane and are obliquely posterior-dorsal and anterior-ventral in direction (fig. 117); four of the resulting daughter cells ($A^{6.2}$, $A^{6.4}$) lie around the anterior border of the egg just below the equator, while the other four ($A^{6.1}$, $A^{6.3}$) form a row across the dorsal surface of the egg just in front of the second cleavage plane (fig. 117). The former are composed of yolk and protoplasm in about equal parts, and give rise to chorda and neural plate cells; the latter are rich in yolk, but have little protoplasm and give rise to endoderm.

The four posterior-dorsal cells divide a little later than the anterior ones, and the spindles lie approximately in a transverse direction (figs. 117, 189). The protoplasm of these cells is chiefly crescent substance; the small posterior cells ($B^{5.2}$) are almost entirely composed of this substance, while the larger cells ($B^{5.1}$) are composed of this substance and yolk in about equal proportions, the former occupying the outer half of the cell and the latter the median half. These larger cells divide equally so as to cut off all of this crescent substance and a small amount of yolk in the lateral daughter cells and to leave but little protoplasm and much yolk in the median ones (figs. 37, 39). This division occurs at the 20-cell stage, and when it is completed all of the mesodermal or crescent substance is finally and completely separated from the endoderm, and, except for a small amount of yellow protoplasm which lies close around the nuclei of many of the blastomeres, all the crescent substance is contained in the four cells which form the posterior border of the dorsal hemisphere (figs. 39, 40). The small posterior cells divide a little later than these larger ones and unequally, the median daughter cells being smaller than the lateral ones (figs. 41, 42, 119). Thus there come to be six mesodermal cells, three on each side of the mid-line, during this cleavage.

Divisions begin in the ventral hemisphere before they are finished in the dorsal (figs. 118, 191). In the most anterior and posterior pairs of cells of this hemisphere ($a^{5.3}$, $b^{5.4}$) the spindles are nearly parallel with the median plane; in the two remaining pairs of cells ($a^{5.4}$ and $b^{5.3}$) the spindles are oblique from posterior-ventral to anterior-dorsal (figs. 118, 191). The division of the anterior pair of cells ($a^{5.3}$, figs. 118, 119) gives rise to a couple of cells ($a^{6.5}$, $\underline{a}^{6.5}$) which lie just above the equator and in contact with the chorda-neural-plate cells of the dorsal hemisphere. Later development shows that these cells form part of the anterior portion of the neural plate; the only other cells of the ventral hemisphere which enter into the formation of this plate are portions of the cells $a^{6.7}$, which lie on the lateral borders of the cells $a^{6.5}$. All of the cells of the ventral hemisphere are of practically the same size and constitution; each consists of a superficial layer of protoplasm, in which the nucleus lies, and a deeper layer of yolk, the cells of this pole being decidedly protoplasmic as compared with those of the opposite pole.

The result of this cleavage is the formation of sixteen cells in each hemisphere which may be tabulated as follows:

Ventral hemisphere
- 14 ectoderm cells, protoplasmic.
- 2 neural plate cells, protoplasmic.

Dorsal hemisphere
- 6 endoderm cells, yolk laden.
- 4 chorda-nerve[1] cells, yolk and protoplasm.
- 6 mesoderm cells, yellow protoplasm or crescent substance.

32 cells.

At the close of this cleavage the cells of the ventral hemisphere are smaller in superficial area than those of the dorsal hemisphere; when viewed from the ventral pole the dorsal cells are seen around the entire periphery of the egg, except at a point on the right and left sides where a single ventral cell ($b^{6.5}$, $\underline{b}^{6.5}$) occupies the periphery; this is the only cell of the ventral hemisphere which can be seen from the dorsal pole (figs. 119, 192, 193). A similar condition prevailed at the close of the preceding cleaving (figs. 116, 117, 190), the only cells of the ventral hemisphere which could be seen from the dorsal pole being $b^{5.3}$ and $\underline{b}^{5.3}$. This condition may be traced still farther back to the 8-cell stage (figs. 108, 110, 184) where the ventral cells are smaller than the dorsal ones and where the only portion of the ventral hemisphere which lies below the general plane of the equator is that part of each of the posterior-ventral cells ($b^{4.2}$, $\underline{b}^{4.2}$) which meets the anterior-dorsal cell in the cross furrow (figs. 108, 184).

At the close of the fifth cleavage the superficial area of the ventral cells is smaller than at any preceding stage and that of the dorsal cells is greater; this is due to a change in the shape of the cells, the ventral cells becoming long and col-

[1] Throughout this paper the cells which are to give rise to chorda, nerve, muscle and mesenchyme are, for the sake of brevity, frequently referred to as if they had already given rise to these structures.

umnar, while the dorsal cells become relatively broad and flat (text figs. XI, XII, XIX, XX). This change of shape has been observed and commented upon by Van Beneden and Julin, Samassa, and Castle, and both of the latter authors attribute the columnar form of the ventral cells to the pressure exerted upon them by the overgrowth of the cells of the dorsal hemisphere; both regard this overgrowth as the beginning of gastrulation (epibole). Whatever may be the cause of the shapes of the cells at the two poles, whether purely mechanical or not, it is certain that this is not the beginning of gastrulation, since, as I will show later, the columnar cells of this stage become the flattened ectoderm cells of later stages, while the flattened cells of this stage become the columnar endoderm cells of the gastrula.

6. *Sixth Cleavage; 32–64 cells.* (Figs. 43–45, 120–130, 194–197).

In this cleavage the divisions are not synchronous, the cells of the dorsal hemisphere dividing before those of the ventral as in the preceding cleavage, and some of the cells in the posterior half dividing later than those in the anterior one. Accordingly it would be possible to sub-divide the period between the 32–cell and 64–cell stages into a 44–cell, a 46–cell and a 48–cell stage, as Castle does. These stages, however, are of brief duration and all the cells of the sixth generation divide before any of the seventh do; therefore, the sixth cleavage is distinct from preceding and succeeding ones.

The spindles appear in the four chorda-neural-plate cells at the anterior border of the dorsal hemisphere in a nearly dorso-ventral direction. The four ventral products of this division ($A^{7.4}$, $A^{7.8}$) form a band of small cells around the anterior border of the egg just dorsal to the equator; these cells ultimately give rise to the posterior part of the neural plate; the dorsal products ($A^{7.3}$, $A^{7.7}$) give rise to the chorda (figs. 119–123). The neural plate cells are small and contain little or no yolk, whereas the chorda cells are larger and are yolk-laden (text figs. XIX, XXI, XXIII); this cleavage of these cells is therefore markedly differential.

While these cells are dividing, all of the endoderm cells divide; these are the four median cells which meet at the vegetal pole ($A^{6.1}$, $\underline{A}^{6.1}$, $B^{6.1}$, $\underline{B}^{6.1}$), and a single pair of cells which lie lateral to these and in front of the transverse (second cleavage) plane ($A^{6.3}$, $\underline{A}^{6.3}$). The spindles in the median cells are antero-posterior in direction, while those in the lateral cells are nearly transverse (figs. 120, 121, 123). These divisions are equal and non-differential in the median cells; in the lateral cells the division is differential, the inner product ($A^{7.5}$) being rich in yolk, the outer ($A^{7.6}$) containing more protoplasm; the former is an endoderm cell, the latter, according to Castle, mesenchyme. By these divisions ten endoderm cells are produced, five on each side of the mid-line, and two mesenchyme cells (figs. 44–46).

While the divisions of the endoderm and chorda-neural-plate cells are occurring, the most anterior mesoderm cell ($B^{6.2}$, $\underline{B}^{6.2}$), forming the point of the crescent on each side, divides, the spindle lying in a nearly dorso-ventral direction (figs. 43, 44, 120–129, 193, 194). This division, in fact, sometimes slightly precedes that of

the anterior cells. The products of this division are nearly equal in size but are qualitatively dissimilar, the dorsal one ($B^{7.3}$) containing less of the yellow protoplasm and more yolk than the ventral one ($B^{7.4}$). This difference between these daughter cells is plainly visible in the living condition, the dorsal cell being a fainter yellow than the ventral one (figs. 43–48, *et seq.*); in preparations the dorsal cells always stain more deeply than the ventral ones, owing to the greater quantity of clear protoplasm which they contain (text fig. XXII). This difference in the constitution of these cells corresponds to a difference in their fate; the dorsal cells give rise to mesenchyme, while the ventral ones produce some of the muscle cells of the tail of the tadpole.

The division of these twelve cells of the dorsal hemisphere are practically synchronous, and they advance the egg from the 32-cell to the 44-cell stage. A little later the second cell of the crescent on each side of the mid-line ($B^{6.4}$) divides, its spindle standing in a nearly dorso-ventral direction (figs. 45, 127–129). The dorsal daughter cell ($B^{7.7}$) in this case also contains less yellow protoplasm and more yolk than the ventral one ($B^{7.8}$), and like the cell which immediately adjoins it anteriorly ($B^{7.3}$) gives rise to mesenchyme, while the ventral moiety becomes a muscle cell. By this division the mesenchyme and muscle substance of the crescent are finally and completely segregated into separate cells, and the number of cells in the crescent is advanced to ten, and in the entire egg to forty-six. This division of the cell $B^{6.4}$ is sometimes delayed until the cells of the ventral hemisphere are dividing (figs. 127–129), and a 46-cell stage is therefore not always present. The division of the last remaining cells of the dorsal hemisphere, the middle cells of the crescent ($B^{6.3}$ $\underline{B}^{6.3}$), is delayed until divisions are well advanced in the ventral hemisphere, and it may occur even after the ventral cells have divided (fig. 47). I do not find, therefore, that there is commonly a 48-cell stage such as Castle describes.

The divisions of the cells of the ventral hemisphere are all synchronous, as figures 124 to 129 show. The direction of the spindles in the different cells is so different that it is difficult to give an exact description of them. In the four median cells which surround the animal pole ($a^{6.8}$, $b^{6.8}$ and their fellows of the right side) the spindles are transverse; the spindles are also nearly transverse in the most anterior and most posterior pairs of cells ($a^{6.5}$, $b^{6.7}$); in the only other pair of cells which meet along the mid-line, the second pair in front of the animal pole ($a^{6.5}$), the spindles are nearly antero-posterior. In the other three pairs of cells of this hemisphere ($a^{6.7}$, $b^{6.5}$, $b^{6.6}$) the spindles are oblique in position, and their directions can be best appreciated by consulting the figures (*v.* figs. 124, 196). The most anterior pair of cells ($a^{6.5}$) are neural plate cells; these cells divide transversely (figs. 124–126), forming a transverse band of four cells just above the equator; on each side of these a single cell ($a^{7.13}$, fig. 130) is added at the close of this cleavage which completes the number of neural plate cells that are derived from the ventral hemisphere. In figure 130 the band of six cell ($a^{7.9}$, $a^{7.10}$, $a^{7.13}$ and their fellows of the right side) which lie around the anterior border of the ventral hemisphere are these neural plate cells.

All the divisions of the cells of the ventral hemisphere are equal, and all

the daughter cells are similar in appearance. By this cleavage the cells of the ventral hemisphere are increased to thirty-two, and when the small posterior cells ($B^{6.3}$, $\underline{B}^{6.3}$) of the dorsal hemisphere have divided there are thirty-two cells in this hemisphere also, or sixty-four in the entire embryo, all in the seventh generation (figs. 130, 131). Tabulating these facts we find that there are at the close of the sixth cleavage the following cells:

Ventral hemisphere
- 26 ectoderm cells, protoplasmic.
- 6 neural plate cells, protoplasmic.

Dorsal hemisphere
- 10 endoderm cells, yolk laden.
- 4 chorda cells, yolk laden.
- 4 neural plate cells, protoplasmic.
- 4 mesenchyme cells, light yellow protoplasm.
- 2 anterior mesenchyme cells, clear protoplasm.
- 2 posterior mesenchyme cells, clear protoplasm.
- 6 muscle cells, deep yellow protoplasm.

64 cells.

At the beginning of the sixth cleavage the cells of the ventral hemisphere are narrow and columnar, while those of the dorsal hemisphere are broad and flat (text figs. XI, XII, XIX, XX). This condition prevails up to the 44-cell stage when the cells of the ventral hemisphere begin to divide. During their division the ventral cells become shorter and broader, and at the same time the dorsal cells, which have passed into a resting stage, grow more columnar and much smaller in surface area, and before the close of this cleavage the cells at both poles are columnar and of about the same height (text figs. XIII, XIV, XXI). This change in the shape of the cells of the two hemispheres, which begins during the sixth cleavage, is not completed until the seventh cleavage of the ventral cells (figs. 133, 134, 198–204). During this change of shape there is no difficulty in distinguishing the two hemispheres, for the endoderm cells are filled with yolk and the mesoderm cells with yellow protoplasm or crescent substance, whereas the cells of the ventral hemisphere are largely protoplasmic (text figs. XVII–XXIV). Moreover, the polar bodies are often attached to the egg at its animal pole throughout the whole of this period (*cf.* figs. 190–204).

I have already discussed the views of Van Beneden and Julin, of Samassa and of Castle relative to the shape of the cells of the two hemispheres. Although Van Beneden and Julin showed by their figures that the dorsal cells of the 32-cell stage of *Clavellina* are flat and the ventral ones columnar, whereas the dorsal cells of the 44-cell stage are columnar and the ventral ones flat, they did not observe nor attempt to explain this change of shape. On the other hand, as we have seen, Samassa and Castle denied that such a change of shape took place, and they therefore reversed Van Beneden and Julin's orientation of all stages before the 44-cell stage. I have already given what seems to me satisfactory and sufficient evidence in favor of the orientation of Van Beneden and Julin, and against that of Samassa and Castle, and I need not repeat that evidence here.

Turning now to a detailed study of the observations of Samassa and Castle during this critical sixth cleavage, we find that Samassa did not attempt to follow the cell-lineage further than the 48-cell stage (his fig. 9), but jumped at once from this stage to one with at least 76 cells (his fig. 10). His orientation of all stages up to and including the 48-cell stage (his fig. 9) is the reverse of that of Van Beneden and Julin, and is wrong; his orientation of the gastrula, shown in his figure 10, is right. Therefore, in the interval between his figures 9 and 10 he has inverted the egg so that the dorsal face of his figure 10 corresponds to the so-called ventral face of all preceding figures.[1]

Castle, on the other hand, has traced the cell-lineage much further than the 48-cell stage, and it is therefore possible to follow in detail the manner in which he passes from the erroneous orientation of earlier stages to the correct orientation of later ones. He has given correctly the lineage of every cell up to and including the 46-cell stage (his figs. 55 and 56), as I have convinced myself by comparing his figures, cell for cell, with my own, but his orientation of these stages should be reversed. On the other hand his orientation of all stages later than the 46-cell stage is correct, but the cell lineage of these stages is wrong. This is due to the fact that between the 46-cell and the 48-cell stages (his figs. 56 and 57) he has inverted the egg so that the dorsal surface of all stages later than the 46-cell stage corresponds with the so-called ventral surface of all earlier stages.[2] This inversion of the egg introduces many profound errors in the cell-lineage after the 46-cell stage.

Considering in detail Castle's account of this sixth cleavage we find that he has correctly represented the divisions of the cells of the real dorsal hemisphere which bring these cells up to the seventh generation and the entire egg up to the 46-cell stage (his fig. 55). At this stage the cells of the ventral hemisphere are still in the sixth generation (*v.* his fig. 56), and this stage is almost exactly comparable with my figures 119 to 123. Immediately after this, in the 48-cell stage (his figs. 57 and 58), Castle supposes that the cells of the real dorsal hemisphere, which are now in the seventh generation, divide again, thus passing into the eighth generation, while the sixth generation cells at the opposite pole are supposed by him to remain undivided. It is absolutely essential to his scheme of orientation that the cells of one hemisphere should remain in the sixth generation, while those of the other hemisphere are advancing to the seventh and eighth generation. If it could be shown that all the cells of both hemispheres divide during this sixth cleavage it would completely break down Castle's orientation of the earlier stages and his cell-lineage of the later ones. In all of his figures of this cleavage (figs. 55, 56, 57, 58) Castle represents the cells at one pole in process of division while those at the other pole are in the resting condition. However, in two of my figures of this cleavage in *Ciona* (figs.

[1] In his explanation of figures he says that figure 9 is viewed from the cephalic pole; this is, of course, a verbal error, since his lettering of the cells shows plainly that the egg is viewed from the caudal pole.

[2] Unfortunately Castle gives no dorsal, ventral nor lateral views of this critical 48-cell stage at which the inversion occurs, but only an anterior and a posterior view (his figs. 57 and 58, reproduced in text figs. XXV and XXVI of this paper).

196 and 197), which represent ventral and dorsal views of one and the same egg, the cells at both poles are seen to be in process of division, and the only cells in the entire embryo which are not dividing are the small posterior cells ($B^{6.3}$). The cells of the dorsal hemisphere are in the late anaphase or telophase, and their nuclei are still small and densely chromatic; the cells of the ventral hemisphere are all in the equatorial plate stage. *These figures show most conclusively that all the cells of the embryo divide during this sixth cleavage and are advanced from the sixth to the seventh generation, and they therefore make impossible Castle's view that the cells of the dorsal hemisphere remain undivided, while those of the ventral hemisphere divide twice.* Another evidence that the cells which are shown dividing in his figures 57 and 58 are not the same ones which have just divided in his figure 55 may be found in the fact that but sixteen of these cells are shown dividing in the former figures, whereas the other sixteen cells, which, according to Castle, belong to the ventral hemisphere, are in the resting stage, exactly as are the sixteen cells which immediately surround the dorsal pole; at the two previous cleavages, and as I have found also, at the two subsequent ones, all the cells of the ventral hemisphere divide simultaneously, and this fact speaks against Castle's view that at the 48-cell stage one-half of these cells divides and the other half does not.

Since the dorsal hemisphere, shown in his figure 55, contains twenty-eight cells of the seventh generation and two of the sixth, while the ventral hemisphere shown in figure 56 contains only sixteen cells of the sixth generation, it is evident that if the egg is inverted in its orientation at this stage the equator must be shifted nearer to the dorsal hemisphere so as to reduce the number of dorsal cells to sixteen and to increase the number of ventral cells to thirty, or, after the division of the two small posterior cells, to thirty-two. This is just what Castle has done; in his description of the 48-cell stage (pp. 238, 239) he says that at this stage the embryo is composed of three zones of sixteen cells each, as follows:

Ventral hemisphere

16 cells of the seventh generation, ectodermal group.

16 cells of the seventh generation, equatorial band.

Dorsal hemisphere

16 cells of the sixth generation, endoderm, chorda and mesoderm.

48 cells.

Immediately after this stage the 64-cell stage is reached by the division of the sixteen cells of the ectodermal group. Castle has tabulated the cells of this stage as follows:

Ventral hemisphere

32 cells in the eighth generation, ectodermal group.

16 cells in the seventh generation, the equatorial band.

48

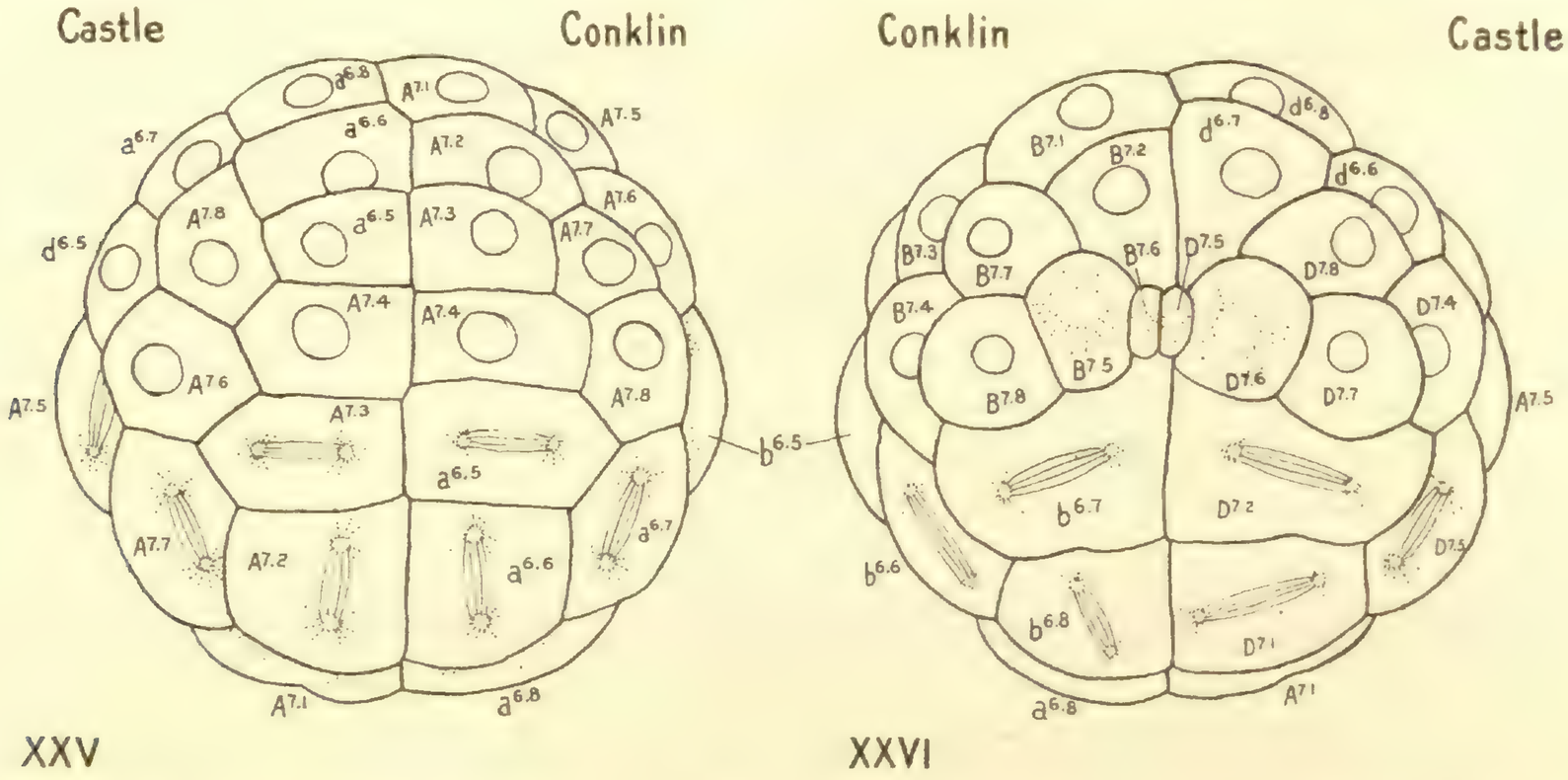
Dorsal hemisphere

16 cells in the sixth generation.

64 cells.

As it can be proved that no cells of this stage remain in the sixth generation, but all have passed into the seventh, it is certain that the equator both here and in the 48-cell stage is in the wrong place, that it really lies between his equatorial band and the ectodermal group, and that there are therefore thirty-two cells in each hemisphere in the 64-cell stage.

Wholly apart, therefore, from the perfectly conclusive evidence as to the orientation of the egg and embryo which may be drawn from the histological character of the cells at the two poles, as well as from the location of the polar bodies, it can be shown by a detailed study of the cell-lineage that Castle has inverted the egg at the 48-cell stage, transferred sixteen cells from the dorsal to the ventral hemisphere and consequently shifted the equator of the embryo at least one cell row nearer the dorsal pole than it should be. Of course the lineage of every cell is thereby pro-



FIGS. XXV and XXVI.—Surface views of eggs of *Ciona intestinalis;* copied from Castle's figures 57 and 58 (1896). Fig. XXV represents an anterior view; Fig. XXVI a posterior one of the same egg. The orientation and cell-lineage, according to Castle, are indicated by the designations of the cells in that half of the egg under his name; the designations of the corresponding cells in the other half of each figure shows the system of orientation and cell-lineage adopted in this paper. Owing merely to differences in nomenclature the cells in the right half of Fig. XXVI are designated by the letter D, those on the left by the letter B. Everywhere lower-case letters designate cells of the animal (maturation) hemisphere; capitals, cells of the hemisphere opposite the maturation pole. The equator lies between the cells designated by lower-case and capital letters.

foundly changed; the only cells which retain a semblance of their former names throughout this revolution are the small posterior cells ($C^{7.5}$, $D^{7.5}$ of Castle's system), and their sisters ($C^{7.6}$, $D^{7.6}$), the most anterior cells of the crescent of each side ($C^{7.4}$, $D^{7.4}$), and the most anterior pair of cells of the dorsal hemisphere ($A^{7.4}$, $B^{7.4}$). Even in the case of these four pairs of cells the right and left cells of each pair are interchanged, so that everywhere A should replace B, and C, D.

In subsequent stages Castle does not always preserve the same designations for given cells. For example, the cell which in his figure 58 is labelled $A^{7.8}$ becomes $a^{6.7}$ in fig. 60; $a^{6.7}$ of figure 58 becomes $d^{6.5}$ of figure 60, while the one labelled $d^{6.5}$ in the former figure becomes $A^{7.6}$ in the latter. Strangely enough this last cell which had been variously located in the dorsal and ventral hemispheres, and in the

anterior and posterior quadrants is finally brought back to its right position and given its true designation. In all stages later than his figure 60 the designation $A^{7.6}$ stands for the same cell in Castle's figures and in my own.

The changes in the designations of the cells which are brought about by this inversion of the orientation at the 48-cell stage may be most easily seen and appreciated by a reference to the accompanying text figures XXV and XXVI, where the designations of the cells, according to my interpretation, are given on the right side of figure XXV and on the left side of figure XXVI, while Castle's designations of the corresponding cells are given on the left side of figure XXV and on the right side of figure XXVI. Barring the exceptions mentioned in the preceding paragraph, Castle has followed with substantial accuracy the subsequent lineage of the dorsal hemisphere up to a stage of about one hundred and twelve cells, though always upon the basis of his erroneous lineage of the 48-cell stage. With the exception of a single pair of cells, I need not further explain my departure from Castle's nomenclature of the later stages. This exception is the pair of small posterior mesenchyme cells which Castle designates $C^{7.5}$, $D^{7.5}$; inasmuch as I find that they lie ventral to their sister cells, I shall designate them $B^{7.6}$, $\underline{B}^{7.6}$, and their more dorsally placed sister cells $B^{7.5}$, $\underline{B}^{7.5}$.

With the completion of the sixth cleavage we reach a period when the gastrulation is ready to begin. Already preparations for the gastrulation are apparent in the changing shapes of the cells of the dorsal and ventral hemispheres, in the relative positions of the cells and in the directions of their divisions. *Even the peculiar type of the chordate gastrula, with its overgrowing anterior lip and its nearly stationary posterior one, is foreshadowed at a very early stage in the eccentric position of the animal and vegetal poles in the two hemispheres of the egg.*

In the 32-cell and 64-cell stages it is apparent that the animal and vegetal poles do not mark the middle of the ventral and dorsal faces of the embryo. This was first noticeable in the 4-cell stage of *Cynthia* where the two posterior cells are smaller than the anterior ones. In the 8-cell stage the anterior-ventral cells are elongated antero-posteriorly, while the posterior-ventral ones are elongated transversely; this brings the animal pole still farther back of the middle of the ventral face. In the 16-cell stage there are two pairs of cells adjoining the mid-line in front of the animal pole and but one pair behind it; in the dorsal hemisphere there is one pair of such cells in front of the vegetal pole and two behind, but the most posterior pair is smaller than the others, so that the vegetal pole lies near the middle of the dorsal face. In the 32-cell stage three pairs of cells adjoining the mid-line are in front of the animal pole, two behind it; while in the dorsal hemisphere there are two pairs of such cells in front of the vegetal pole and two behind it, though here again the most posterior cells are very small ones. In the 64-cell stage (figs. 130, 131) there are four pairs of cells adjoining the mid-line in front of the animal pole and only two pairs behind it; while in the dorsal hemisphere there are four pairs of such cells, both in front of and behind the vegetal pole, but the most posterior pair are the tiny mesenchyme cells ($B^{7.6}$, $\underline{B}^{7.6}$) which are partly cov-

ered by their sister cells ($B^{7.5}$, $\underline{B}^{7.5}$). Thus the vegetal pole is slightly posterior to the middle of the dorsal face and the animal pole is decidedly posterior to the middle of the ventral face in all of the stages mentioned, and this condition becomes even more pronounced in later stages; thus in the 124-cell stage (fig. 139) there are, ventral to the equator, six pairs of cells adjoining the mid-line in front of the animal pole and four behind it, while in the 184-cell stage (fig. 143) there are eight pairs of such cells in front of the animal pole and five behind it; in the 218-cell stage (fig. 144–147) there are ten such pairs of cells in front of the animal pole and only five behind it. All of the cells of the ventral hemisphere are of approximately the same size, so that in these later stages it is evident that the animal pole lies far back of the middle of the ventral hemisphere. This location of the animal pole posterior to the middle of the ventral hemisphere is due in the first instance to the smaller size of the posterior cells in the 4-cell stage and then to the fact that the prevailing position of the spindles in the anterior cells of this hemisphere is parallel with the median plane, while in the posterior cells it is transverse. It is not due, as might at first thought seem to be the case, to the more rapid growth and division of the anterior cells of the ventral hemisphere since all of these cells divide at nearly the same time and are of approximately the same size. The prospective significance of this eccentric location of the animal pole may be found in the greater length of the anterior lip of the blastopore, as compared with the posterior lip.

C. Gastrulation; Seventh to Ninth Generation of Cells, 64–218 Cells.

In both *Ciona* and *Cynthia* the gastrulation actually begins during the seventh cleavage and it is far advanced by the close of the eighth, though the closure of the blastopore and the completion of the gastrulation does not occur until about the end of the tenth cleavage. I have followed the lineage of every cell through the seventh cleavage and of almost all the cells through the eighth, and have therefore been able to determine the part which each cell takes in the formation of the gastrula. At no time after the 64-cell stage are all the cells of the embryo in the same generation. From this time foward the endoderm cells lag behind the ectoderm and mesoderm cells in division; the eighth cleavage occurs in the ectoderm and mesoderm before the seventh is finished in the endoderm. Therefore the periods of the seventh and eighth cleavages cannot be sharply separated, but for the sake of convenience we shall consider these two cleavages as if they were distinct.

7. *Seventh Cleavage; 64–76, 76–112 cells.* (Figs. 46–51, 130–139, 198–204.)

The seventh cleavage begins in the anterior quadrants of the dorsal hemisphere in the two pairs of chorda cells ($A^{7.3}$, $A^{7.7}$) and in the two pairs of neural plate cells ($A^{7.4}$, $A^{7.8}$); in the posterior quadrants it begins in the two most anterior cells of the crescent on each side, the pair of muscle cells, $B^{7.4}$, and the pair of mesenchyme cells, $B^{7.3}$ (figs. 130–132). With the exception of the two mesenchyme cells the spindles in all of these cases are parallel with the plane of the equator and with the surface of the egg; in the mesenchyme cells the spindles, when seen from the dor-

sal side, are directed obliquely forward, outward and ventralward (figs. 131, 132). These divisions, when completed, give rise in the anterior quadrants to four chorda cells ($A^{8.5}$, $A^{8.6}$, $A^{8.13}$, $A^{8.14}$), and to four neural plate cells ($A^{8.7}$, $A^{8.8}$, $A^{8.15}$, $A^{8.16}$) on each side of the mid-line, which are arranged in two rows of eight cells each running around the anterior border of the dorsal hemisphere (figs. 134, 200). All these divisions are equal and non-differential.

In the posterior quadrants the division of the anterior muscle cell on each side gives rise to two daughter cells ($B^{8.7}$, $B^{8.8}$), one in front of the other, which are alike in size and quality. The mesenchyme cell ($B^{7.3}$) divides unequally and differentially giving rise to a small yolk-laden cell ($B^{8.6}$), lying anterior, lateral and ventral to its large sister cell ($B^{8.5}$), which is more protoplasmic (figs. 134, 200). The former is, according to Castle, the "posterior chorda fundament" while the latter is mesenchyme. I have been unable to find sufficient evidence that this small cell is later incorporated in the chorda, but on the other hand do not wish to deny that this is the case. Since it is derived from the mesenchyme I prefer to class it with the mesenchyme cells until its fate is more certainly known. These divisions advance the embryo to the 76-cell stage and the distribution and generations of the cells may be summarized as follows:

Ventral hemisphere							
Ectoderm				7th	generation	26	cells.
Neural plate				7th	"	6	"
Dorsal hemisphere							
Endoderm				7th	"	10	"
Chorda	8th	generation	8 cells.				
Neural plate	8th	"	8 "				
Muscle	8th	"	4 "	7th	"	2	"
Mesenchyme	8th	"	4 "	7th	"	8	"
	8th	generation	24 cells.	7th	generation	52	cells.
						76	cells.

The classification of the cells of this stage into chorda, neural plate, muscle and mesenchyme,[1] must of course be based upon the later history of these cells, but even at this early stage important differences may be recognized in the histological characters of the cells named. In the living eggs of *Cynthia* the endoderm cells are slate-gray in color and are filled with yolk; the chorda cells are lighter gray and contain less yolk than the endoderm cells; the ectoderm and neural plate cells are clear and protoplasmic; while the muscle and mesenchyme cells are yellow, the former being more deeply colored than the latter. In the main my classification of the cells of this stage agrees with that of Castle; the most important difference concerns the muscle cells which he classes as "neuro-muscular cells." Owing to the striking color of these cells in *Cynthia* their later history can be followed with relative ease; they ultimately give rise to the three rows of muscle

[1] See note p. 52.

cells in the tail of the tadpole (figs. 58, 59), and so far as I am able to determine do not contribute anything to the nervous system. In general the mesenchyme cells may also be traced by their faint yellow color until they give rise to the mesenchyme of the tadpole, and, with the exception of the small cell which Castle calls the "posterior chorda fundament," I agree with him as to the fate of these cells. Castle figures and describes the cell, $A^{7.6}$, as the most anterior of the mesenchyme cells. I do not find that it contains yellow protoplasm in *Cynthia*, but its histological structure is different from that of the other endoderm cells; I shall therefore follow Castle in classing it as a mesenchyme cell. The median cells of the crescent ($B^{7.5}$) resemble in their deep yellow color, the muscle cells rather more than the mesenchyme, and Castle reckons these cells with the "neuro-muscular ring," but the later history of these cells shows that they lie just beneath the notochord and at the hinder end of the ventral endodermal cord in the tail of the tadpole (figs. 161–165); therefore, they do no give rise to the lateral muscles, and they are probably to be counted as mesenchyme cells.

At this stage, therefore, the endoderm consists of four pairs of cells meeting along the mid-line (figs. 134, 200), and of one pair of laterally placed cells which lie just in front of the second cleavage plane; the chorda consists of an arc of eight cells bounding the endoderm in front; in front of the chorda cells and below the equator is an arc of eight neural plate cells. Posteriorly the endoderm is bounded by an arc of twelve mesenchyme cells, while just outside these is an arc of six muscle cells (eight, in fig. 134). The neural arc in front is separated from the muscle arc behind by the most dorsally situated of all the ectoderm cells ($b^{8.17}$). But for this lateral interruption it would be possible to speak of a "neuro-muscular ring" as Castle does. The chorda and mesenchyme arcs form a continuous chorda-mesenchyme ring, as Castle has shown.

Castle asserts (1896, p. 246) that the mesenchyme "is made up of cells derived from both hemispheres and all four quadrants," and again that two cells "*viz.* $d^{7.12}$ and $c^{7.12}$ [my $B^{8.5}$] are the sole contribution of the dorsal hemisphere to the mesoderm of the larva" (p. 242). This is certainly not the case; the mesenchyme and muscle cells are derived entirely and exclusively from the dorsal hemisphere and largely from the posterior quadrants. The most posterior cells of the crescent on each side ($B^{8.16}$ and its mate) are counted by Castle as part of the ectoderm; their histological structure, color in the living egg of *Cynthia* and later history show that they are the most posterior of the muscle cells. Of two other cells of this stage, Castle says (p. 242), "it is noticeable that $d^{6.5}$ and its mate $c^{6.5}$ have been shoved forward out of their own quadrants to a position beside the endoderm cells derived from the anterior quadrants." These cells are really $A^{7.5}$ and its mate, as is shown by their origin and later history (figs. 120, *et seq.*), and do not belong to the posterior but to the anterior quadrants.

The 76-cell stage is of very short duration, for immediately after those divisions in the dorsal hemisphere which advance the embryo from the 64-cell to the 76-cell stage, all the cells of the ventral hemisphere divide simultaneously. The

direction of the spindles in these cells is indicated by the equatorial plates represented in figures 198 to 203. In the posterior quadrants all the spindles are nearly antero-posterior in direction, except in those three ventral cells on each side ($b^{7.9}$, $b^{7.10}$, $b^{7.11}$) which lie nearest to the dorsal surface and between the muscle cells behind and the neural plate cells in front (figs. 201, 203); in these cells the spindles are nearly vertical. In the anterior quadrants the spindles are antero-posterior in a transverse row of four cells which lies just in front of the animal pole ($a^{7.16}$, $a^{7.15}$); in the row of four cell just in front of this the spindles are transverse ($a^{7.12}$, $a^{7.14}$); they are also transverse in a single pair of cells which meet at the midline just in front of the last mentioned row ($a^{7.11}$); in the most anterior row of the ventral hemisphere, consisting of six neural plate cells ($a^{7.10}$, $a^{7.9}$, $a^{7.13}$), the spindles are dorso-ventral in position, therefore, at the close of this division there are twelve neural plate cells in the ventral hemisphere, arranged in two rows of six cells each.

All of these divisions of the cells of the ventral hemisphere are synchronous, equal and non-differential, and they increase the number of cells in the ventral hemisphere to sixty-four and bring the whole number of cells in the embryo up to one hundred and eight.

Very soon after these divisions in the ventral hemisphere the posterior muscle cell ($B^{7.8}$) and one of the mesenchyme cells ($B^{7.7}$) of each side divide; in the former the spindles converge posteriorly and ventrally toward the median plane, in the latter posteriorly and dorsally. By this division two mesenchyme and two muscle cells are added to the total in the embryo which at this stage consists of one hundred and twelve cells (fig. 133, 134[1]) which may be tabulated as follows:

Ventral hemisphere

Ectoderm	8th generation,	52	cells.					
Neural plate	8th generation,	12	cells.					

Dorsal hemisphere

Endoderm						7th gen.,	10	cells.
Chorda	8th generation,	8	cells.					
Neural plate	8th "	8	"					
Muscle	8th "	8	"					
Mesenchyme	8th "	8	"	7th	"	6	"	
	8th generation,	96	cells.	7th gen.,		16	cells.	
						112	cells.	

The only cells in the entire embryo which have not passed into the eighth generation at this stage are the ten endoderm cells, and six mesenchyme cells, two of which are anterior, and four median and posterior; all of these cells except two, the small posterior mesenchyme cells ($B^{7.6}$), divide soon after this stage and thus pass into the eighth generation, but not until after other cells have passed into the ninth. This stage, therefore, may be taken as representing, as nearly as may be found, the close of the seventh cleavage and the transition to the eighth.

[1] The division in a pair of mesenchyme cells ($B^{7.7}$) of this stage is not completed; therefore, in the explanation of figures, this is called a 110-cell stage.

This stage is important as marking the beginnings of gastrulation for which preparations were made in preceding stages. The endoderm cells and the four posterior mesenchyme cells which remain in the seventh generation now lie at a considerably lower level than the surrounding cells. This, although usually spoken of as an invagination, can scarcely with right be called such, for as sections show there is neither at this stage, nor at any preceding one, any considerable blastocoel; since there is no cavity into which the cells can push it is scarcely permissible to speak of their invaginating. In reality the gastrulation is due to two factors, neither of which is invagination. The first and most important is the change of shape of the cells, which has been described in part already; the second is the overgrowth of the cells lying around the endodermal area.

As to the first we have already seen that in the 16-cell stage the cells at both poles are of about equal height; during the fifth cleavage the cells at the animal pole become long and columnar, while those at the vegetal pole are broad and flat; during the sixth cleavage the cells at the two poles change shape so that at the close of this cleavage (64-cell stage) the cells of both poles are of nearly equal height, those at the vegetal pole being perhaps slightly longer than those at the animal pole. At this stage the cells of the dorsal (vegetal) hemisphere still have a larger surface area than those of the ventral (animal) hemisphere, so that when viewed from the vegetal pole only cells of the dorsal hemisphere can be seen, but when viewed from the opposite pole a peripheral row of dorsal cells can be seen around those of the ventral hemisphere (figs. 130, 131). During the seventh cleavage this change of shape progresses rapidly so that at the 76-cell stage the surface area of the dorsal cells is less than that of the ventral ones; the endoderm cells in particular grow long and narrow, whereas the ectoderm cells become broad and flat (figs. 198–204). After the seventh cleavage of the ectoderm and mesoderm cells (112-cell stage) a row of ventral hemisphere cells is visible all around the periphery of the dorsal hemisphere when the embryo is viewed from the dorsal pole (figs. 133, 134). The remarkable reduction in the surface area of the endoderm cells, which occurs without any division in these cells, and wholly by their change of shape will be best appreciated by comparing figures 131 with 134, and figures 197 with 200; in all of these figures the endoderm cells are in the seventh generation, but the superficial area of these cells in the two older stages is not more than half as great as in the two earlier ones. In proportion as these cells decrease in surface area they increase in depth, their inner ends become enlarged, and at the same time their nuclei are withdrawn from the surface to a deeper level in the cells (text figs. XXI–XXIV). The flattening of the ectoderm cells leads to their covering a larger and larger surface area until they finally overgrow the marginal cells of the dorsal hemisphere. Samassa undertook to explain the columnar form of the cells at the animal pole in the 32-cell stage by the pressure exerted on them by the overgrowing cells of the opposite pole, but it is obvious that neither at this early stage, nor during the later one just described, can the cause of this change of shape be located in the cells of one hemisphere rather than in those of the other.

The second factor of the gastrulation, *viz.*, the overgrowth of the cells surrounding the endodermal area has been well described by Castle. It is the result in part of the first factor and also of the more rapid division of the cells of the ectoderm and the corresponding retardation of division in the endodermal cells. This overgrowth occurs in the anterior quadrants from in front, the chorda cells overgrowing the endoderm and the neural plate cells the chorda; in the posterior quadrants it occurs from the sides, the muscle cells overgrowing the mesenchyme, and the ectoderm the muscle cells. At three points this overgrowth is long delayed, at the posterior pole where there is a deep notch in the blastoporic rim which persists until the blastopore has nearly closed, and at the right and left sides of the blastopore where the overgrowth is slow. This leads to the peculiar form of blastopore, wide in front and narrow behind, which is found among ascidians.

8. *Eighth Cleavage; 112–132 cells, 132–218 cells.* (Figs. 135–147, 205).

The eighth cleavage first appears in the two anterior muscle cells of each side ($B^{8.8}$, $B^{8.7}$), the spindles being nearly transverse to the antero-posterior axis of the embryo (figs. 135, 136). This division is equal and non-differential, and there result four muscle cells on each side, an anterior pair ($B^{9.15}$, $B^{9.16}$) and a posterior pair ($B^{9.13}$, $B^{9.14}$). When first formed the median cells of each of these pairs lie at a higher level than the lateral ones (fig. 135); soon afterward the lateral and median cells are at the same level (fig. 136); still later the lateral ones lie at a higher level than the median ones (fig. 140). This is, of course, a result of the overgrowth, whereby the cells which were lateral in the blastopore lip come to overly those which were median in position.

At the same time that these muscle cells are dividing the pair of large mesenchyme cells, $B^{8.5}$, divides, the spindles being obliquely antero-posterior and dorso-ventral in direction (figs. 135, 136). This division is approximately equal and non-differential, and gives rise to the mesenchyme cells $B^{9.9}$, $B^{9.10}$, which lie on each side of the caudal endoderm cells.

While these divisions are proceeding in the mesoderm, and thereby advancing these cells to the ninth generation, the delayed seventh cleavage appears in the mesenchyme and endoderm cells. The first of these cells to divide is the most anterior mesenchyme cell ($A^{7.6}$); the spindles are here nearly dorso-ventral in direction, and the resulting daughter cells ($A^{8.11}$, $A^{8.12}$) are of about the same size, though the dorsal cell contains more protoplasm than the ventral one, as Castle has shown.

Coincidently with these divisions two pairs of endoderm cells ($A^{7.2}$ and $B^{7.2}$) divide, the spindles being approximately transverse in the anterior pair and antero-posterior in the posterior one (fig. 135).

A little later the four endoderm cells which meet at the vegetal pole ($A^{7.1}$, $B^{7.1}$, fig. 136) divide, the spindles being antero-posterior in direction. The last remaining pair of endoderm cells of the seventh generation to divide is the lateral one ($A^{7.5}$, figs. 135, 136); I have not seen this cell in division, but it is probable from a study of later

stages that the spindle lies in it also in an antero-posterior direction. All of these divisions of the endoderm are equal and non-differential.

Finally the median mesenchyme cells, $B^{7.5}$, divide, the spindles being antero-posterior (fig. 136), and the resulting daughter cells alike in size and quality.

With this division all the cells of the embryo have passed into the eighth generation, except the small posterior mesenchyme cells ($B^{7.6}$) which never again divide, so far as I have observed; and excepting eight muscle cells and four mesenchyme cells which have passed into the ninth generation. The following tabular statement summarizes the character and location of the cells at the close of this stage:

Ventral hemisphere

Ectoderm				8th gen.,	52	cells.	
Neural plate				8th "	12	"	
Dorsal hemisphere							
Endoderm				8th "	20	"	
Chorda				8th "	8	"	
Neural plate				8th "	8	"	
Muscle	9th gen.,	8	cells.	8th "	4	"	
Mesenchyme,	9th "	4	"	8th "	14	"	7th gen., 2 cells.
	9th gen.,	12	cells.	8th gen.,	118	cells.	7th gen., 2 cells.

132 cells.

The 132-cell stage is not a sharply defined one, for before all the divisions which have been described above have been finished, other divisions are begun which lead to the 184-cell stage (figs. 136–143). The cells which divide first in this period are the four median neural plate cells $A^{8.7}$, $A^{8.8}$ (fig. 136); shortly afterward the four lateral ones $A^{8.15}$, $A^{8.16}$ (fig. 140), also divide. The spindles in all these cells lie in a radiating position around the blastopore, and as a result of this division there are produced in the dorsal hemisphere two rows of neural plate cells, eight cells in a row, situated at the anterior border of the blastopore and dorsal to the chorda cells.

About the same time forty-four of the fifty-two ectoderm cells divide; the spindles are approximately transverse in all these cells, except in the most posterior row of the ventral hemisphere, where they are dorso-ventral, and in two transverse rows of four cells each, which are the third and fourth rows in front of the animal pole (figs. 139, 143), where the spindles are antero-posterior in direction.

By these divisions the dorsal neural plate cells are increased to sixteen, and the ectoderm to one hundred and eight cells, so that at this stage the entire embryo contains one hundred and eighty-four cells. Twenty cells, forming two rows of ten each around the anterior border of the embryo just ventral to the equator, remain undivided for some time and are conspicuous for the large size of their resting nuclei and their more deeply staining cytoplasm (figs. 138, 142). The four hindmost of these cells on each side belong to the posterior quadrants ($b^{8.17}$, $b^{8.18}$, $b^{8.19}$, $b^{8.20}$); the other six pairs ($a^{8.25}$, $a^{8.26}$, $a^{8.17}$, $a^{8.18}$, $a^{8.19}$, $a^{8.20}$) which form the lateral

anterior portions of these rows, are derived from the anterior quadrants, and they form the anterior portion of the neural plate.

Finally in the stage shown in figures 144 to 147, these twenty cells divide, all the spindles being approximately dorso-ventral in direction. About the same time the eight chorda cells divide, the spindles standing in a dorso-ventral direction (fig. 145), and a little later the six most anterior endoderm cells ($A^{8.2}$, $A^{8.3}$, $A^{8.4}$) divide, the spindles being nearly transverse (fig. 147). These thirty-four divisions advance the embryo from 184 to 218 cells.

Beyond this point I have not attempted to follow the lineage of each and every cell; this could be done successfully only by a most exacting study of serial sections in connection with whole preparations. With sufficient labor and material I believe that the lineage of every cell could be traced through to the tadpole stage, but I have lacked both the time and the material for such a study. Tabulating the cells of this stage we find that there are:

Ventral hemisphere										
Ectoderm	9th gen.,	104	cells.							
Neural plate	9th	"	24	"						
Dorsal hemisphere										
Endoderm	9th	"	12	"	8th gen.,	14	cells.			
Chorda	9th	"	16	"						
Neural plate	9th	"	16	"						
Muscle	9th	"	8	"	8th	"	4	"		
Mesenchyme	9th	"	4	"	8th	"	14	"	7th gen.,	2 cells.
	9th gen.,	184	cells.		8th gen.,	32	cells.		7th gen.,	2 cells.

218 cells.

At this stage the gastrula is nearly circular in outline when viewed from the dorsal or ventral pole; the gastrocoel is a cavity deep and wide in front and narrow behind, where it opens to the exterior through a deep groove between the mesenchyme and muscle cells of each side. The endoderm lies at a deep level, in contact with the ectoderm of the ventral side; in the anterior quadrants it consists of nine pairs of cells which become the gastric endoderm of the larva, in the posterior quadrants are four pairs of endoderm cells which meet along the median plane; the two posterior pairs become the caudal endoderm of the tadpole, the two anterior pairs are added to the gastric endoderm. Three pairs of cells at the hinder end of this cord of caudal endoderm are mesenchyme, while on each side of these and running forward lateral to the caudal endoderm are seven pairs of large mesenchyme cells (in fig. 147 only five pairs are visible, since two lie at a deeper level, one beneath the cell $B^{8.14}$ and another beneath $A^{8.12}$). The muscle rudiment consists of six pairs of large cells, dorsal to the mesenchyme, on each side of the blastopore groove and still uncovered by ectoderm. The chorda consists of sixteen cells arranged in two rows of eight each, one ventral to the other, and covered superficially by cells of the neural plate. Sixteen cells of the neural plate which cover the chorda

cells and form the anterior border of the blastopore belong to the dorsal hemisphere; the rest of this plate is composed of cells of the ventral hemisphere, arranged in four rows of six each, and lying just in front of the chorda region; therefore in the 218-cell stage the nerve plate consists of forty cells arranged in six transverse rows, each containing six cells except, the two most posterior rows which contain eight each. The animal pole, with the polar bodies still attached, is still situated back of the middle of the ventral face, six cell rows posterior to the anterior edge of the neutral plate; there are but five rows of cells of the ventral hemisphere posterior to the animal pole, while there are ten such rows in front of it.

V. LATER DEVELOPMENT.

My observations on the later stages of development agree in the main with those of previous workers and particularly with those of Castle, who made a thorough study of these stages by means of serial sections. It is true of these stages, however, as it is of the cleavage stages, that many topographical relations can be made out more satisfactorily by a study of entire preparations. I have therefore devoted especial attention to such preparations, and my observation, both on living and on stained material, are embodied in plates V and X.

1. *Closure of Blastopore.*

During the closure of the blastopore the embryo changes shape and at the same time the egg axis is shifted. This stage is therefore an important one in the orientation of the later stages. The gastrula is at first disk-shaped (fig. 134), it then becomes saucer-shaped (fig. 136) and then cup-shaped (figs. 144, 145). During this change as the embryo increases in depth it decreases in its other dimensions so that it becomes more nearly spherical (fig. 145). The closure of the blastopore takes place more rapidly from the anterior than from the posterior side; in fact after the general drawing together of the margins of the saucer-shaped gastrula the posterior lip remains nearly stationary until the last stage in the closure of the blastopore.

Soon after the 218-cell stage the gastrula becomes elongated and egg-shaped, the posterior end being somewhat narrower than the anterior. The anterior lip of the blastopore continues to grow posteriorly while the lateral lips draw nearer together; thus the blastopore becomes T-shaped (fig. 148), and finally, by the further growth of the anterior lip, the anterior part of the blastopore, represented by the bar of the T, is covered and the blastopore is reduced to a longitudinal groove between the lateral lips (figs. 152, 153). In the growth of the lateral lips they come to lie at a higher level than the anterior lip, and consequently as the latter continues to grow posteriorly, the former are tilted up at their anterior ends until they become vertical in position. These lateral lips are at first formed only of the muscle cells, but later the ectoderm cells completely overgrow them.

In this process the ectoderm does not, for some time, close up the notch at the posterior end of the blastopore (fig. 52); this is one of the last steps in the process of closure.

The overgrowth of the anterior lip continues until it has covered about three-quarters of the dorsal face; meanwhile the animal pole is shifted nearer to the point of greatest curvature at the anterior end, and the blastopore is transported from the dorsal side toward the posterior end. In this process the rows of muscle cells which at an earlier stage stretched from the posterior pole to the second cleavage plane, and were antero-posterior in direction, are tilted up at their anterior ends and pushed backwards until they lie at the hinder end of the embryo and run in a dorso-ventral direction (figs. 52, 53, 56, 157). This complete change in the direction of the rows of muscle cells I found most perplexing and difficult to understand. In early stages the crescent, and the mesoderm cells which form from it, lies just below the equator of the egg, and in the antero-posterior plane; in these later stages the muscle cells are transverse to the anterior-posterior axis. A detailed study of intermediate stages shows how this change is brought about. After the closure of the anterior part of the blastopore, corresponding to the bar of the T, the anterior lip does not overgrow the blastopore groove (stem of the T) and its lateral walls, which are composed of the muscle cells; on the other hand, these lateral walls lie at a higher level than the anterior lip, and the continued growth of this lip pushes the muscle cells and the groove before it. As the posterior lip remains stationary during this process it happens that the entire dorsal portion of the posterior quadrants is tilted up in front and pushed backward until it forms the posterior end of the embryo, the posterior lip becoming ventral and the anterior lip dorsal in position. Thus the blastopore groove, which lay on the dorsal side posterior to the middle, comes to lie at the posterior end of the embryo and the walls of the groove, containing the muscle cells, come to be terminal in position and vertical in direction (figs. 50–53). The mesenchyme cells, as well as the caudal endoderm, lie at so low a level that they are not disturbed by the overgrowth of the anterior lip, consequently the rows of these cells still preserve an antero-posterior direction (fig. 157). Thus the mesenchyme and muscle cells, which in earlier stages lay side by side, come to be separated anteriorly, and only remain in contact with one another at the hinder end of the strand of caudal endoderm cells; the mesenchyme cells in this region are derived from the median part of the crescent and they ultimately become separated from the remaining portion of the mesenchyme which comes to lie in the trunk (figs. 161–167).

These general changes in the shape of the embryo at this stage are accompanied by divisions of many of the cells, some of which we may now consider. In all the ectoderm cells the ninth cleavage is nearly synchronous; in the posterior quadrants the spindles are approximately antero-posterior in direction, and the same is true for the two hindmost rows of the anterior quadrants, but in most of the other cells of the anterior quadrants the spindles are transverse, thus it happens that the animal pole is shifted forward (fig. 149). As compared with

the eighth cleavage there is therefore a regular alternation in the direction of division in most of the cells. I have not observed the tenth cleavage of these cells, but it seems probable that the direction of division is, in many of the cells, the same as at the ninth cleavage, if one may judge by the longitudinal rows of cells as well as by the number of rows which are present in the posterior quadrants (figs. 155, 160). The animal pole is, therefore, shifted still further forward during this cleavage. The postero-lateral ectoderm cells slowly overgrow the muscle cells, but for a long time they do not overgrow the median posterior mesenchyme cells, and there is therefore left the deep notch in the blastopore at the hinder end of the embryo which has already been described.

The neural plate in the stage shown in figure 148 consists of six transverse rows of cells, only four of which show in the figure. The two posterior rows are derived from the dorsal hemisphere and consists of eight cells each; the four anterior rows consist of six cells each, and are derived from the ventral hemisphere. In subsequent divisions of the posterior rows of this plate the spindles are antero-posterior in direction, thus adding to the number of rows but not to the number of cells in each row; for example, in figure 152 there are eight rows of cells, but apparently only six cells in each row.[1]

The endoderm cells of the anterior quadrants divide chiefly in a transverse plane; those of the posterior quadrants in an antero-posterior plane (figs. 150, 154, 156). This fact, taken in conjunction with the direction of division in the ectoderm cells, contributes to the lengthening of the posterior part of the embryo and to the widening of the anterior part, and consequently to the shifting of the animal pole further toward the anterior end.

Of the two rows of chorda cells established at the eighth cleavage one has come to lie posterior to the other, and both bend so as to become horse-shoe-shaped (fig. 153). Later these cells divide again (fig 157) and, pushing backward with the anterior lip, carry the muscle cells before them, as already described.

In the 218–cell stage there were twenty mesenchyme cells; in the next stage shown (fig. 150) these are increased by one or two divisions so that there are twenty-two or twenty-four cells. As in the preceding stage, they still lie on the ventral side next to the ectoderm and along the posterior border of the gastral endoderm. In figure 150 only one row of mesenchyme cells is found lateral to the caudal endoderm; in figures 154 and 156 there are two such rows. In all these figures there are three pairs of mesenchyme cells at the hinder end of the caudal endoderm; the most posterior of these is the small posterior mesenchyme cells ($B^{7.6}$), the others are $B^{8.9}$ and $B^{8.10}$. All of these cells are protoplasmic, stain deeply and are strikingly different in appearance from the endoderm cells.

The muscle cells, which in the 218–cell stage consisted of six pairs of cells, are shown in figures 51 and 153 increased to eight pairs which are arranged in two rows on each side of the blastopore groove. By the continued growth of the ante-

[1] In this figure it is possible that a single row of cells on each side of the stippled area should be reckoned as part of the neural plate.

rior lip these rows are tilted up into a dorso-ventral direction. An optical section of the caudal region at this stage shows four muscle cells on each side, one above another (fig. 158); a lateral view shows three rows of muscle cells with four or five cells in each row (figs. 56, 157). I have not observed the exact manner in which this change from two rows to three takes place, but it is evident that it must be associated with the division of the cells of the original two rows. In figure 51 there are eight muscle cells on each side; in figure 55, thirteen; in figure 56, fourteen; in figure 157, fifteen; in figure 165, eighteen; and in figure 59, twenty; therefore each of the cells shown in figure 51 must have divided once and some of them twice during the period represented by these figures.

2. *Development of Larva* (Figs. 57–60, 160–167).

After the growth of the anterior lip has carried the notochord to a position approximately corresponding to that of the blastopore groove in figure 153 and has shifted the rows of muscle cells into a nearly vertical direction (figs. 157, 158), these rows of muscle cells again come to be antero-posterior in direction (figs. 58, 59, 161–165). This change takes place rather suddenly and I have not observed all the steps in the process. It seems probable, however, that it is due to two factors; (*a*) the depression of the dorsal ends of the muscle rows to a position alongside of the notochord, and (*b*) the outgrowth of the tail of the larva from the region of the ventral ends of the muscle rows. This outgrowth, which is associated with the lengthening of the ventral side of the embryo, carries the caudal mesenchyme cells and the ventral ends of the muscle rows backward into the tail and thus the rows of muscle cells again assume an antero-posterior direction (figs. 58, 59, 161–167). Usually six cells are seen in each row and in addition there are two or more cells at the hinder ends of these rows which do not fall specifically into any one of them. In living embryos the muscle and mesenchyme cells retain their yellow color and the individual muscle cells may be plainly seen; all the figures shown in plate V represent camera drawings of living embryos and in all of them the yellow cells were distinctly visible as drawn.[1] When seen from the caudal pole (fig. 60), the three rows of muscle cells are seen to be only one-layered and the cells of one side are connected with those of the other by a group of small yellow cells (the caudal mesenchyme), which lie ventral to the notochord at its hinder end.

In stained preparations of young tadpoles these caudal mesenchyme cells can be seen to consist of two or three pairs of cells at the posterior end of the caudal endoderm and ventral to the notochord (figs. 161–165). The other mesenchyme cells, which in a former stage (figs. 156, 157) were continuous with this caudal group, are now separated from it by the whole length of the muscle rows. These mesenchyme cells at the anterior ends of the muscle rows are found in later stages

[1] Since this paper was sent to press Misses Foot and Strobell have prepared for me a series of more than thirty photomicrographs of the living eggs and embryos of *Cynthia*. These photographs show in the most striking manner the yellow protoplasm and the cells which arise from it; even in the tadpole stage these individual cells are plainly recognizable in the photographs.

in the trunk of the larva, and they may therefore be known as trunk mesenchyme cells; in figures 161–165 they consist of eight or ten cells on each side. Whether there may be a few scattered mesenchyme cells between the caudal and the trunk groups and ventral to the muscle rows must still be left an open question, but there can be no doubt that most of the mesenchyme cells are located in these two groups. The separation of the caudal from the trunk mesenchyme must have been accomplished in part by the same means which brought the muscle rows from a vertical to a horizontal position, *viz.*, by the outgrowth of the tail. In addition there seems to have been an actual forward movement of the trunk mesenchyme, as is indicated by a comparison of such figures as 156 and 161. This is probably part of the general forward shifting of the animal pole. In later stages when the tail is bent toward the ventral side, the trunk mesenchyme is found ventral to the anterior ends of the muscle rows (figs. 59, 166, 167). In these later stages the mesenchyme cells are frequently found dividing; they are smaller and more numerous than the muscle cells and are more than one cell-layer thick.

In the formation of the larva the ventral cord of endoderm increases greatly in length, being composed in very young tadpoles (fig. 161) of six or seven pairs of cells. These cells form a double row between the muscle cells of each side and ventral to the notochord. In front of the caudal endoderm and notochord lies the gastral endoderm consisting of yolk cells which form a single but rather irregular layer around a small central cavity, the enteron (figs. 161, 162, 164–166).

In young larvæ the chorda cells are wedge-shaped and form two or more rows of cells which interdigitate, as has been described by previous writers. In the latest stage which I have studied (fig. 167) these cells interdigitate to such an extent that they form a single row of disk-shaped or slightly wedge-shaped cells. I have not followed in detail the method by which the two arcs of chorda cells shown in figure 153 are transformed into the double row shown in figure 162, but I see no reason to question the account given of this by Van Beneden and Julin and also by Castle.

The neural plate grows backward with the notochord nearly to the posterior end of the embryo. I can find no evidence in favor of the view that any portion of the nervous system is derived from cells which bound the blastopore groove posterior to the neural plate (figs. 152, 153), nor is there any evidence for the existence of a nerve ring surrounding the blastopore. Since the neural plate, six or eight cells wide at its hinder end, is carried back with the chorda nearly to the hinder end of the embryo where the last trace of the blastopore is found (fig. 53), and since no portion of the nerve cord is found posterior to the blastopore and notochord (figs. 163, *et seq.*), it seems most probable that the hinder portion of the nerve cord, as well as all the rest of it, is derived from the neural plate and not from the lateral lips of the blastopore groove. That the muscle cells do not give rise to the posterior part of the nerve cord, as claimed by Castle, is made probable by the fact that this portion of the nerve cord is not yellow, as are the muscle cells; I cannot therefore accept without further evidence Castle's statement that

the posterior portion of the nerve cord is formed from the muscle cells (his "neuro-muscular" cells). Furthermore, I am unable to find satisfactory evidence that the ectoderm which covers the muscle cells and closes the blastopore notch behind contributes to the formation of the nerve cord. *Therefore, it is probable that the entire central nervous system comes from the neural plate, which is a portion of the anterior lip of the blastopore.*

After having overgrown the muscle cells and closed up the posterior notch of the blastopore the ectoderm forms a pair of V-shaped folds (figs. 52–54), the apex of the V lying just behind the blastopore and the limbs diverging anteriorly and laterally. By the forward extension of these folds the neural plate is rolled up into a tube which is covered with a layer of ectoderm, in the manner characteristic of vertebrates. These folds are at first V-shaped, but after they have extended around the anterior end of the nerve plate they inclose an oval area which is pointed behind (fig. 55). The folds close from behind forward and ultimately convert the entire neural plate into a tube, which retains a lumen in its anterior portion (the sense vesicle) and an opening to the exterior (the neuropore), but which contains no lumen back of the anterior end of the notochord (figs. 166, 167). *That portion of the nervous system dorsal to the notochord and which contains no lumen is derived from those neural plate cells which belong to the dorsal hemisphere and which in origin were intimately associated with the chorda cells; the anterior half of the enlarged portion of the nerve tube lying in front of the notochord (sense vesicle) is derived from those cells of the neural plate which belong to the ventral hemisphere. As nearly as I can determine the anterior end of the neural plate lies about 30° above the original equator of the egg and 60° below the animal pole.* The cephalic pole of the larva lies ventral to the anterior end of the neural plate but dorsal to the animal pole; therefore, the antero-posterior axis coincides neither with the egg axis nor with the equatorial plane but lies mid-way between the two. The egg axis is therefore not dorso-ventral in the larva but is, strictly speaking, postero-dorsal and antero-ventral in direction. Inasmuch as the forward shifting of the animal pole by which this position of the axes is brought about occurs at a late period in the development, and also for the sake of simplicity of expression I have, in accord with all my predecessors, described the egg axis as dorso-ventral in direction in all the early stages.

VI. COMPARISONS WITH AMPHIOXUS AND AMPHIBIA.

The remarkable differentiations apparent in the egg and early cleavage stages of ascidians, the relatively small number of cells present during gastrulation and organogeny, and the comparative ease and certainty with which the axial relations of the egg and embryo can be determined at all stages,—these conditions render the ascidian egg the most favorable in the whole phylum of the chordata for an exact study of the early development. In no other chordate has the cell-lineage been followed in detail up to the formation of definitive organ bases, and no where else in the phylum has it been possible to determine with the same degree of certainty as here the relations of the axes of the egg to those of the gastrula and larva.

It is therefore worth while to compare the early development of ascidians with that of other primitive chordates in order to see what light may thereby be thrown on certain disputed problems. It must, of course, be understood from the beginning that such comparison can have the weight only of suggestion; the problems which have been raised in the study of any group can be solved only by the further study of that group, but comparisons with other forms may be of great service. If evolution be true, if ascidians are genetically related to other chordates, then it must be true that their modes of development are related. Whether the mode of development of ascidians as compared with *Amphioxus* and amphibians is palingenetic or coenogenetic is largely a matter of opinion, and need not concern us here so only it be granted that there is a relationship between these classes in the matter of their development as well as in their later structure.

Klaatsch (1896) has attempted to elucidate certain disputed points in the development of *Amphioxus* by a comparison with the ascidians, proceeding upon the principle that it is well to reason from the relatively known to the relatively unknown, from conclusions in which all agree to questions upon which there is diversity of opinion. Samassa (1898), on the other hand, holds that the ascidian ontogeny has been so greatly shortened and modified as compared with that of *Amphioxus* that it would be much better to explain the former by the latter than the reverse. All this might be true without destroying the value of comparison, but when Samassa further proceeds, as he does in the following sentence, to deny that there is any relationship between the two forms except in a single stage, he takes away all basis of comparison except for that single stage. He says, p. 20, "Nun ähnelt aber die Ascidienentwicklung der des Amphioxus nur in dem einen Stadium, wenn der Urmund geschlossen ist, der Chorda nach hinten auswächst und die Organe der Larva die für Wirbelthiere characteristische gegenseitige Lagerung ziegen . . . Bis zu diesem Stadium ist aber die Entwicklung des Amphioxus und der Ascidien so verschiedenen wie möglich." We have here, if I understand Samassa correctly, homologies which are found only in a single stage of the ontogeny, which have had no beginnings in homologous parts or processes, have neither homological antecedents nor consequents and have therefore arisen *de novo*. This, it seems to me, is the logical conclusion to be drawn from Samassa's statement, and it is one as indefensible on zoological as on philosophical grounds. There are many points of resemblance in the early development of *Amphioxus* and ascidians, as is well known, and such differences as exist are explicable on the general principle of evolution through divergent modification.

The study of the cell-lineage and early development of a large number of annelids and mollusks has shown that in such general matters as the relations of the axes of the egg to those of the gastrula and larva, and the origin of the germ layers and of specific organs from certain blastomere or regions of the egg, there is a high degree of uniformity among members of the same phylum and even among related phyla. It would certainly be surprising if the development of *Amphioxus* and the ascidians should be found to be more dissimilar than that of annelids and gasteropods.

1. *Axial Relations of Egg and Embryo.*

In considering the axial relations of egg and embryo one is confronted at once with the difficulty of determining what is meant by the anterior pole, unless it be defined in terms of structure rather than function. The animal pole is a structurally definite point, but the anterior end of the embryo,—who can say what it is? In the early development of *Amphioxus* and ascidians the point which at one time is most anterior does not continue such for any considerable period, and it is practically impossible to determine the exact point of this rounded anterior portion of the embryo which will become the most anterior part of the body. Not only is the animal pole a structurally definite point but the anterior limit of the neural plate is also, and the relative positions of these two can be determined with considerable accuracy. The result of such a determination shows that there is great similarity among the lower Chordata in that the *anterior limit of the neural plate is always some distance removed from the animal pole*. In ascidians the chief axis of the egg is plainly marked out not only by the well differentiated cleavage cells but also by the polar bodies which in some cases remain attached to the egg at the point of their formation until the blastopore has closed. In the early gastrula the animal pole is slightly posterior to the middle of the ventral hemisphere, the vegetal pole marks the middle of the dorsal hemisphere, and the deepest point of the gastrocoel (text fig. XXVIII). In the closure of the blastopore the anterior lip overgrows the archenteron, and the blastopore, being closed from in front backwards, is finally limited to a longitudinal groove in the posterior half of the dorsal face of the gastrula.

The relation of the egg axis to the embryonic axis is not a simple one, *i. e.*, they neither coincide nor is one at right angles to the other. During the overgrowth of the anterior lip the animal pole is shifted nearer to the anterior end of the gastrula. This may be, and probably is in part, due to a shifting of the point of greatest curvature at the anterior end to a point nearer the animal pole. *The anterior edge of the neural plate never reaches farther forward than about one-third of the way from the equator to the animal pole, and consequently the animal pole lies on the ventral side of the larva but near the head end.* Correspondingly the opposite pole of the extended egg axis lies near the posterior end of the dorsal side and consequently not far from the place where the last trace of the blastopore can be seen.

Previous students of ascidian embryology, and particularly Castle and Samassa, have considered that the egg axis was dorso-ventral and hence perpendicular to the embryonic axis. I at first held the same opinion, but observations on the change of shape of the gastrula and particularly upon the anterior limit of the neural plate during the closure of the blastopore have convinced me of the truth of the position here taken (*cf.* text figs. XXVII–XXIX).

The axial relations are not so evident in *Amphioxus* and amphibians, since the animal and vegetal poles are not so clearly marked as in the ascidians. Hatschek (1881) supposed that the animal pole of the egg in *Amphioxus* was ventral

to the cephalic pole of the embryo; and this view has been supported by Garbowski (1898); on the other hand, Kowalevsky (1867) and many recent writers on the development of *Amphioxus* (Lwoff 1894, Klaatsch 1896, Samassa 1898, Morgan and Hazen 1900), have considered that the most highly arched portion of the late gastrula represents the animal pole. Since this point is said to become the anterior end of the embryo it is evident that according to this view the chief axis of the egg coincides with the chief axis of the embryo and is antero-posterior in direction, whereas in ascidians it has heretofore been claimed that the egg axis is dorso-ventral in direction and hence perpendicular to the same axis in *Amphioxus*.

Such diversity in this most fundamental of all axial relations seems very improbable considering the many points of resemblance between these groups, and at least such conflicting results should be supported by the best of evidence before being given general credence.

Korschelt and Heider in their excellent text book attempt to harmonize these differences in axial relations between *Amphioxus* and the ascidians by regarding the anterior pole of the ascidian gastrula as the animal pole, but I agree with Samassa (1894), and Castle (1896), that the animal pole never comes to lie at the anterior end of the embryo, though unlike them I hold that it does move in that direction.

In *Amphioxus* as in the ascidians the anterior limit of the neural plate is situated some distance behind the most highly arched portion of the gastrula, and even if the latter be regarded as the animal pole it would still be true of *Amphioxus* as of the ascidians that the neural plate does not reach as far forward as the animal pole. But there are reasons for thinking that the animal pole lies ventral to the most highly arched portion of the *Amphioxus* gastrula. Many investigators agree that the animal pole lies opposite the blastopore; Samassa has observed in a small percentage of eggs that the polar body is still attached to the embryo at a time when the blastopore is growing smaller, and in all such cases he found it at the pole opposite the blastopore (although, as he maintains, at the anterior end of the embryo). But the point opposite the blastopore lies ventral to the most highly arched portion of the embryo. Even if it should be assumed that both ventral and dorsal lips grow equally, the animal pole would still be located on the ventral side of the most highly arched portion, owing to the peculiar shape of the embryo; if the dorsal lip grows more rapidly than the ventral, which in the light of what takes place in ascidians and amphibians seems probable, the animal pole must lie still farther toward the ventral side. In any event a considerable space must intervene between the anterior limit of the neural plate and the animal pole.

The work of Garbowski (1898), shows that the longitudinal axis of the larva of *Amphioxus* forms an angle of about 70° with the gastrular axis,—a result which, like that of Hatschek and Sobotta, agrees very closely with my observations on ascidians, and which practically removes the supposed discrepencies in axial relations between these two classes.

On the whole it seems to me that there is every reason for believing that the *relations of the egg axis to the embryonic axis are essentially the same in Amphioxus and ascidians, that in both the egg axis is postero-dorsal and antero-ventral in direction and that in neither does the neural plate extend more than one-third of the way from the equator to the animal pole* (*cf.* text figs. XXVII–XXXII).

If the same axial relations exist in amphibians as in ascidians, the middle of the pigmented hemisphere of the frog's egg does not correspond to the cephalic pole of the embryo but lies ventral to this pole, while the white hemisphere corresponds in the main to the dorsal side. This is approximately the orientation which has been maintained by Pflüger, Roux, Morgan, Kopsch and H. V. Wilson. Kopsch (1900), in particular, has shown that the anterior margin of the neural plate lies some distance below the animal pole, and judging from his figures the axial relations in the embryo of the frog must be almost identically like those in the ascidian (*cf.* text figs. XXXIII–XXXV).

2. *Entrance of Spermatozoon.*

Among ascidians the sperm enters the egg near the vegetal pole; it then moves to the posterior pole where it meets the egg nucleus, and the sperm amphiaster is formed at right angles to the copulation path. The outer pigmented layer of protoplasm collects around the sperm nucleus and moves with it to the posterior pole where the mesodermal crescent is formed.

In *Amphioxus* the sperm also enters near the vegetal pole according to Sobotta (1897), but whether it then moves to the posterior pole and whether there is a collection of superficial protoplasm around the sperm nucleus is unknown.

In the frog the sperm enters on the posterior side just below the equator and, according to Roux, the point of entrance determines the posterior pole of the embryo. Schultze, on the other hand, thought that the point of entrance lay at the anterior pole, but since he also with Roux holds that the entrance occurs at the pole opposite that at which gastrulation begins, it is evident that this difference with regard to the pole of entrance is only part of the larger difference between these authors as to the general orientation of the embryo. The conditions which are found in the ascidian egg closely agree with the orientation of Roux as against that of Schultze.

In another important respect Roux's observations find a parallel in the ascidian egg; he observed that after fertilization the pigment cap of the frog's egg shifts so that its margin lies below the equator on the side of the egg where the sperm enters while at the opposite pole it comes to lie above the equator. I believe that this movement of the pigment is comparable to the movements of the layer of yellow protoplasm in the egg of *Cynthia*.

3. *Cleavage.*

There are many differences in the cleavage of the egg in these three classes of chordates, but some fundamental characteristics are essentially similar in all of them. The most important of these is that the cleavage is usually bilaterally

symmetrical. The first cleavage always coincides with the median plane among ascidians, and every subsequent cleavage is perfectly bilateral, one-half of the egg being the mirrored image of the other. In the frog's egg the first cleavage usually lies in the plane of symmetry[1], and although the subsequent cleavages grow more and more irregular, bilaterality is sometimes strongly expressed even in the later stages (*cf.* M. Schultze, 1863; Rauber, 1882).

In *Amphioxus*, if I correctly understand Wilson (1893, p. 600), the first cleavage coincides with the median plane. In the subsequent cleavages, both Wilson and Samassa (1898) have been unable to find the remarkably regular alternation of meridional and latitudinal cleavages described by Hatschek. These cleavages are extremely variable in form; among them Wilson recognizes three principal types, one radial and two bilateral. After the 16-cell stage, however, almost all the eggs become bilateral, whereas in the 8-cell stage three-fourths of them are radial. Wilson suggests that variations from the bilateral type may occur among ascidians, but I agree with Castle and Samassa that under normal conditions this is never the case. In the 8-cell, 16-cell and 32-cell stages of the bilateral types there are many striking resemblances to corresponding stages of the ascidian; this applies particularly to Wilson's bilateral type II (*cf.* his figs. 13–18, 33, 34, 36, 37–39, 41–43, and Samassa's figs. 2, 6, 7, 9). In these figures the form of the cleavage is so similar and the position of the cells and even the direction of the spindles within the cells so remarkably like what is found in the ascidians that the individual cleavage cells can be correlated in these two animal classes.

Too little is known of the cell-origin of the germ layers in *Amphioxus* to determine accurately how close is the likeness to ascidians in this regard. Wilson holds that the eight animal cells of the 16-cell stage are purely ectodermal and that the "secondary macromeres" (A^2, B^2, C^2, D^2,) which surround, and were derived from, the four basal cells at the vegetal pole are of mixed character, giving rise to both endoderm and ectoderm, and perhaps also mesoderm. He does not give the evidence upon which this conclusion rests, but its similarity to the conditions which exist in the ascidians should not be overlooked. Here also the eight animal cells are purely ectodermal, while the "secondary macromeres," and in fact, all the cells of the vegetal hemisphere in the 16–cell stage are of mixed character, the four anterior ones containing endoderm and ectoderm (neural plate substance), and the four posterior ones, endoderm and mesoderm. Wilson expressly states that he uses the terms macromere and micromere "solely for the sake of convenience," and he concludes that the cleavage is very unlike that of annelids; Samassa also emphasizes this same conclusion.

We may conclude, then, that there are certain fundamental resemblances between *Amphioxus* and ascidians in the matter of cleavage and that the most notable differences between them are found in the number of cells and the degree of their differentiation at any given embryogenic stage; in ascidians this number is rela-

[1] In the newt, *Diemyctylus*, Jordan (1893) found that the first cleavage is perpendicular to the median plane.

tively small and the degree of differentiation high as compared with *Amphioxus*; *e. g.*, at the stage when invagination begins in *Amphioxus* there are according to Wilson about 512 cells, at a corresponding stage in *Ciona* there are 76 cells. It may be presumed that the relative constancy or variability of cleavage in these two classes depends upon the two features just contrasted, viz., the number of the cleavage cells and the degree of their differentiation.

In a general way the same kinds of likenesses and differences exist between ascidians and amphibians in the matter of cleavage as between the former and *Amphioxus*. Among amphibians, however, these differences are further increased by the presence of a relatively large quantity of yolk. Whether the ectoderm comes entirely from the four upper cells of the 8-cell stage in these animals cannot be affirmed, but it is evidently derived in chief part from these cells.

4. *Blastula and Gastrula.*

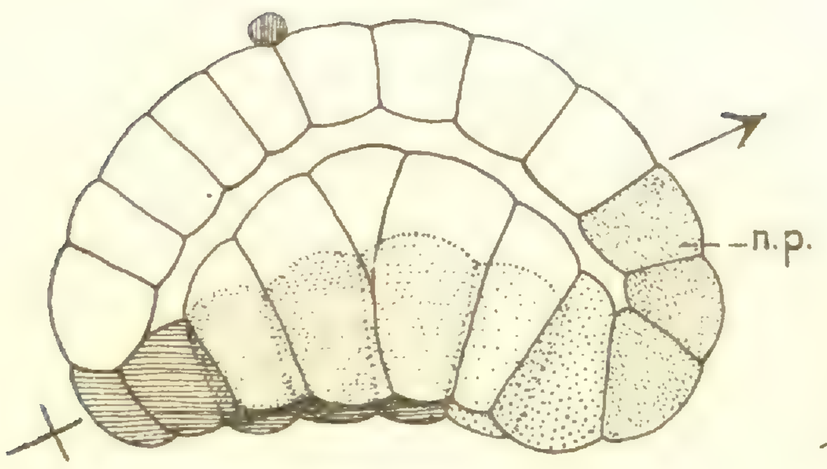
The form of the blastula and gastrula is much influenced by the relative amount of yolk in different cases. A large coeloblastula, such as is present in *Amphioxus*, does not occur in the ascidians or amphibians. In the ascidians this is due not merely, nor largely, to the amount of the yolk but rather to the shape of the cells which are always elongated either at one pole or the other so as to nearly fill the blastocoel; the latter is small at all stages and the embryo and larva very compact. In the amphibians the relatively small size of the blastocoel is due not only to the quantity of yolk, but also to the many-layered character of the blastula wall.

In all three classes the ectoderm arises from the upper hemisphere of the blastula, the endoderm and mesoderm from the lower hemisphere, but the precise relation of these germ layers to the third cleavage plane is not known in the cases of *Amphioxus* and the Amphibia.

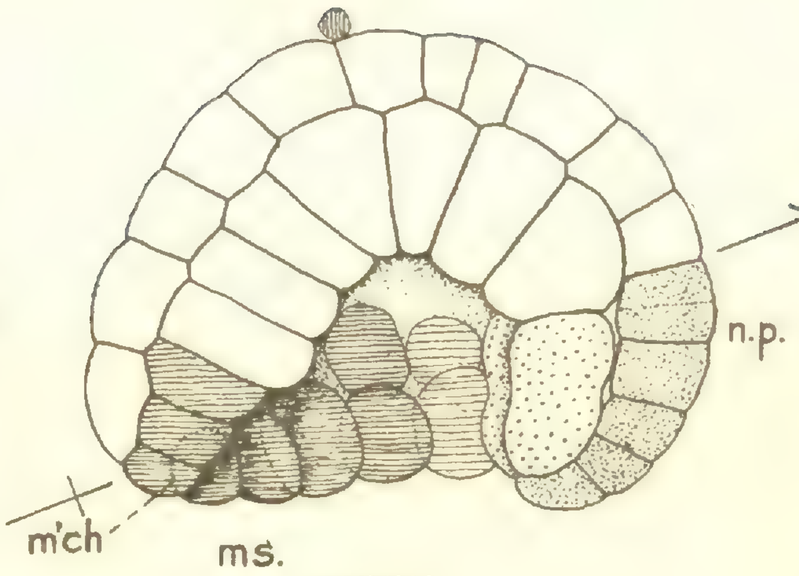
Most investigators affirm that the gastrula invagination in *Amphioxus* is at first radially symmetrical, and only in the later stages does it become unsymmetrical. Samassa (1898), on the contrary, finds that the gastrula is bilateral from the beginning and concludes that this bilaterality is the direct outcome of the bilaterality of the cleavage stages. In both ascidians and amphibians it is bilateral from the first, the invagination appearing near the anterior border of the dorsal face and then extending so as to include most of the dorsal area.

5. *Closure of Blastopore.*

In ascidians the closure of the blastopore results largely from the progressive posterior growth of the anterior (dorsal) lip, while the posterior (ventral) lip remains relatively fixed in position. Owing to the peculiar differentiation of the cells of the blastopore lip they can be individually followed through a large part of this process; the number of cell rows between the posterior lip and the animal pole and between the anterior lip and that pole can also be determined with accuracy during the earlier stages of the closure; from both of these facts it is certain



XXVII



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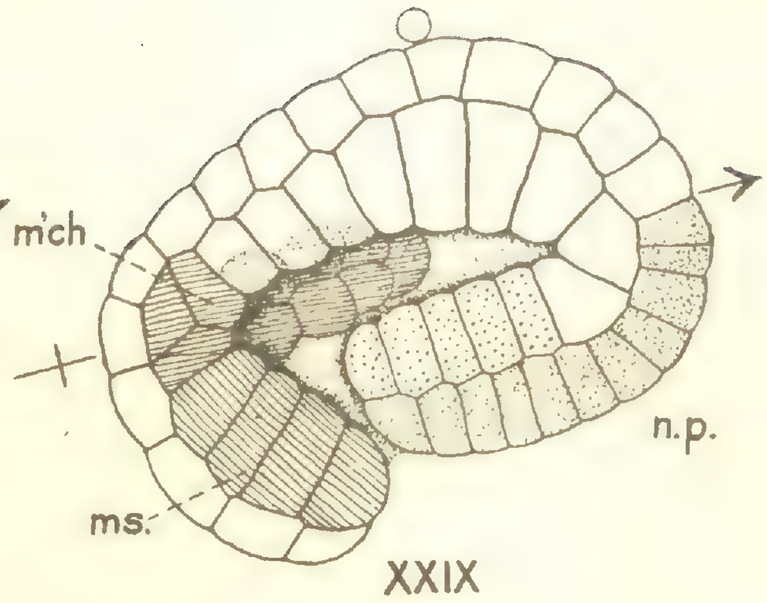

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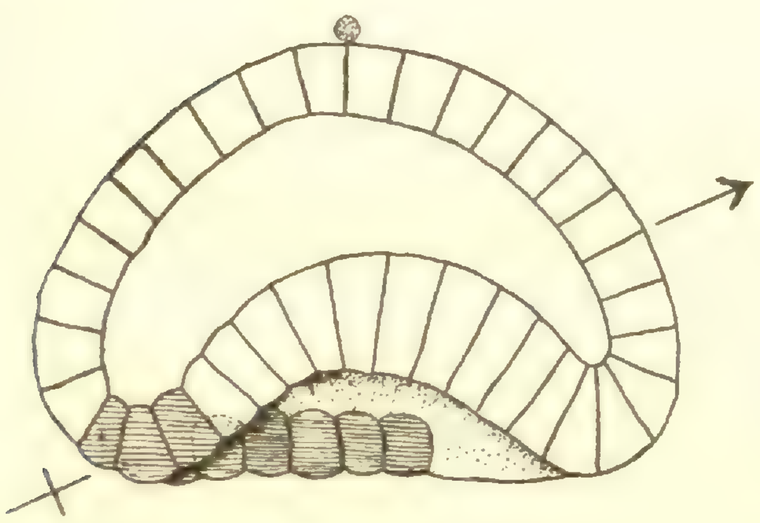

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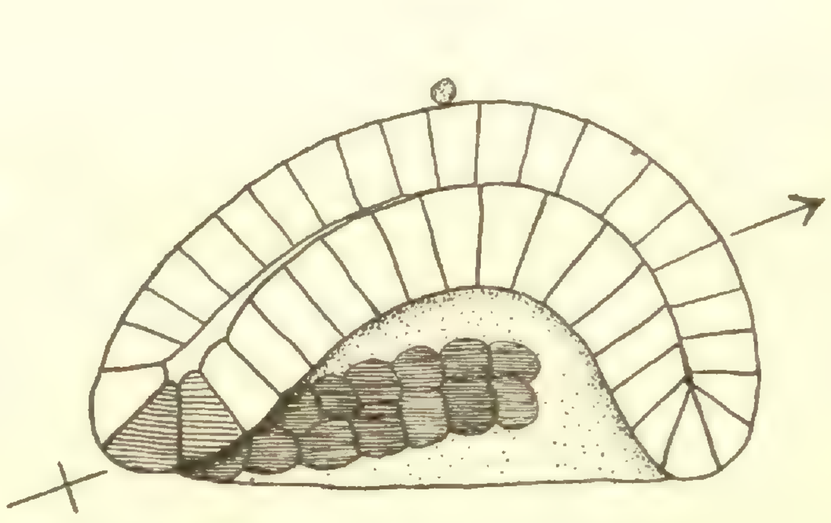
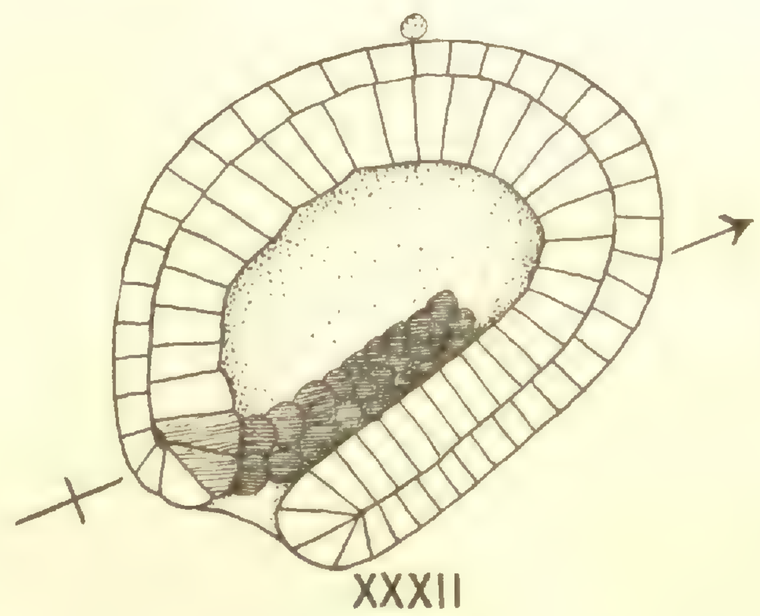
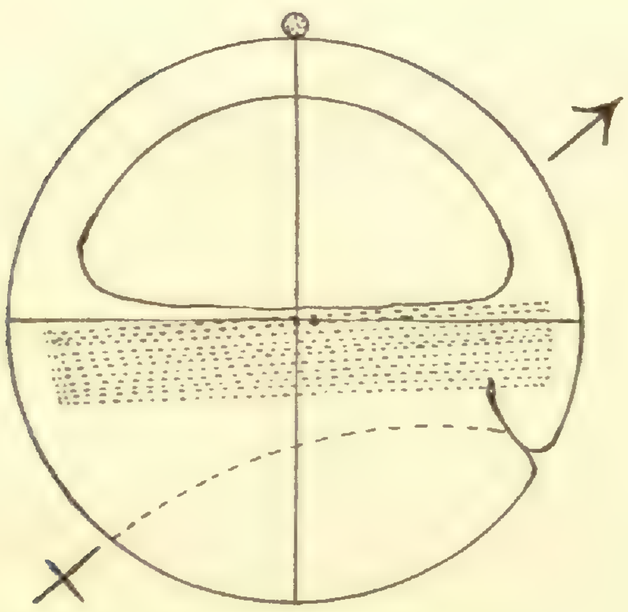


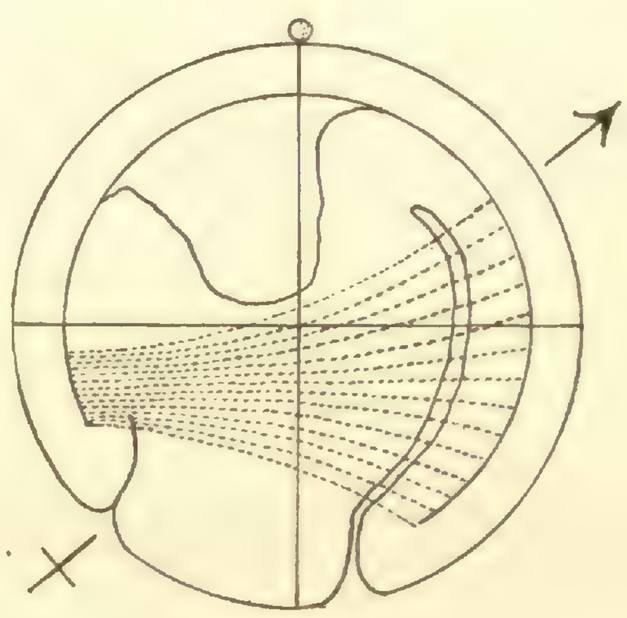
XXXI



XXXII



XXXIII



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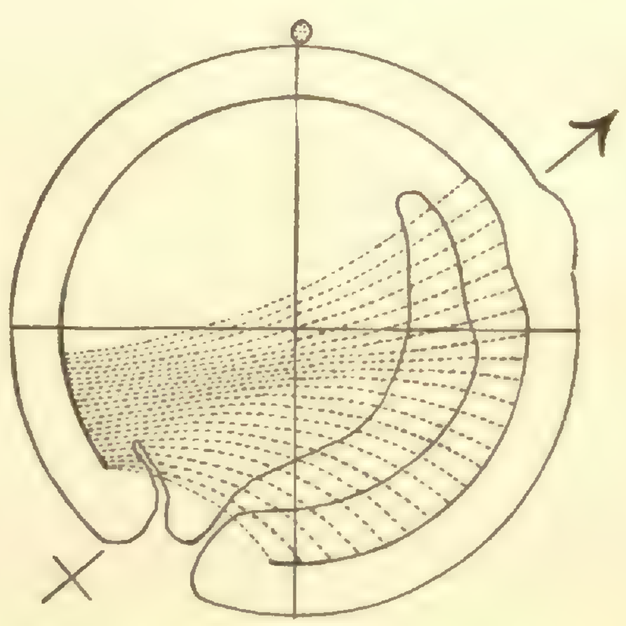

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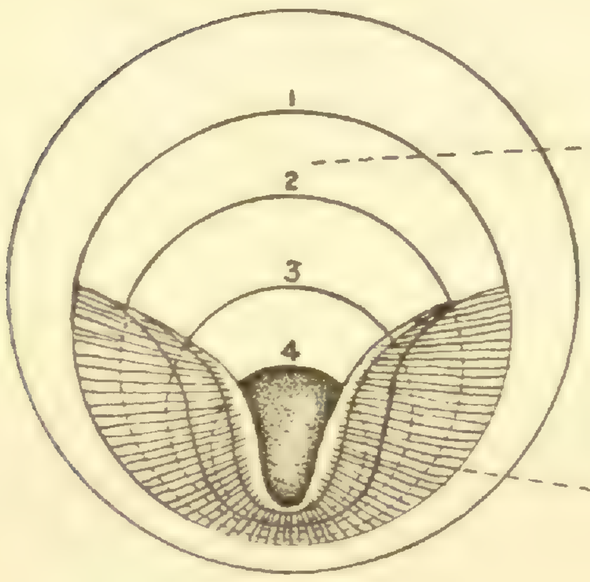

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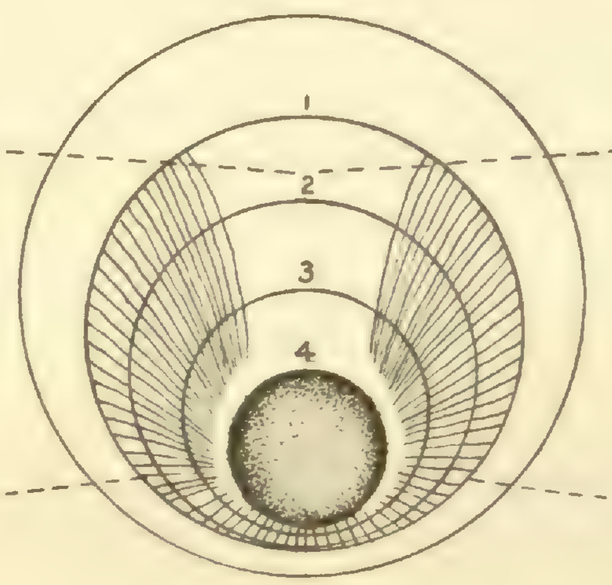
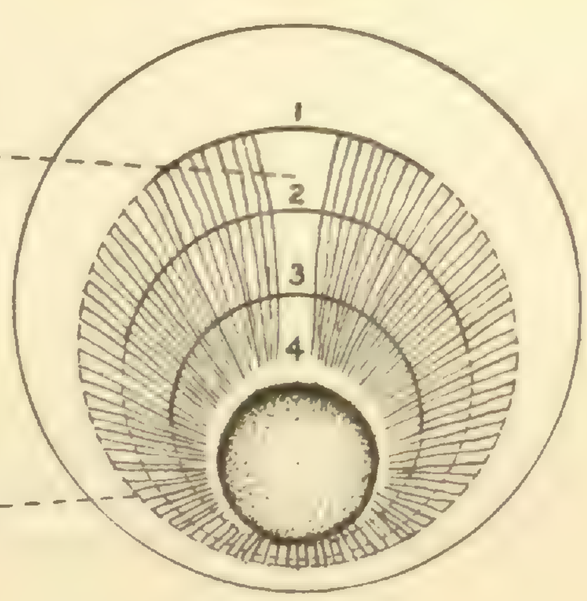


XXXVII



XXXVIII

FIGS. XXVII-XXXVIII.—Schematic representations of three stages in the gastrulation of an ascidian, of *Amphioxus* and of an amphibian to show their supposed resemblances in (1) Axial Relations, (2) Closure of Blastopore, (3) Origin of Neural Plate, (4) of Chorda and (5) of Mesoderm. The position assigned to the polar bodies in *Amphioxus* and the amphibian is to a certain extent hypothetical. The head of the arrow marks approximately the anterior limit of the neural plate; the tail of the arrow, the median mesenchyme cells in the posterior (ventral) lip of the blastopore. The mesodermal cells or areas are shaded by entire or broken lines.

FIGS. XXVII-XXIX.—Right halves of bisected gastrulae of *Cynthia;* the chorda cells are shaded by coarse stipples, the neural plate cells (n. p.) by fine stipples. The muscle cells (m.s.) lie lateral to the mesenchyme cells (m'ch) and by the overgrowth of the anterior (dorsal) lip of the blastopore are separated from the mesenchyme cells anteriorly (XXIX).

FIGS. XXX-XXXII.—Right halves of bisected gastrulæ of *Amphioxus* (mainly after Hatschek). In the two earlier stages the existence and position of the mesoderm is hypothetical, being based upon the conditions found in ascidians.

FIGS. XXXIII-XXXV.—Right halves of bisected gastrulæ of the frog (mainly after Kopsch). The areas shaded by stippled lines represent the supposed position of the mesoderm, here covered by endoderm and yolk.

FIGS. XXXVI-XXXVIII.—Dorsal views of late gastrulæ of ascidian (XXXVI), *Amphioxus* (XXXVII), and frog (XXXVIII). The circles marked 1, 2, 3, 4 indicate successive stages in the closure of the blastopore. The actual position of the mesoderm in the ascidian and its supposed position in *Amphioxus* and the frog is shown by the radiating lines around the blastopore. The unshaded area (Ch.) anterior to the blastopore and between the halves of the mesoderm represents the plate of chorda cells.

that the posterior lip takes only a small part in the closure of the blastopore, except in the final stages of that process. The posterior border of the blastopore is formed of mesodermal cells derived from the crescent; these cells are larger and more rounded than the cells of the anterior border and are easily distinguishable by their color and texture. In the closure of the blastopore they are rolled in at the lateral margins but not at the hinder end, and owing to the large size of these "myoblasts" the posterior portion of the blastopore is reduced to a longitudinal groove. Finally, this groove is closed by growth from all sides, the posterior lip growing more rapidly than the anterior one in the final stages of the process.

The earliest trace of the anterior lip appears just posterior to the chorda cells, the endodermal cells here becoming depressed (fig. 134); at this stage the chorda cells and the neural plate cells which lie just anterior to them are at the same level, but in the posterior growth of this lip the chorda cells are rolled in so that they form the inner, as the neural plate cells form the outer, layer of the anterior (dorsal) lip. None of the neural plate cells and none of the ectodermal cells are ever inrolled, the only cells which suffer this fate being the chorda cells and the muscle cells (myoblasts).

There has been much controversy as to the part played by the anterior and the posterior lips in the closure of the blastopore in *Amphioxus* and the amphibians. Kowalevsky supposed that the closure in *Amphioxus* occurred in a radially symmetrical manner, the entire border of the blastopore growing equally; Hatschek thought that the growth of the anterior (dorsal) lip was the chief factor in the closure; Lwoff, Klaatsch, Samassa, Morgan and Hazen agree in the main with Kowalevsky. MacBride (1898) finds that in the final stages of closure the ventral lip grows more rapidly than the dorsal.

Among the amphibians, observation and experiment show that the overgrowth of the dorsal lip is greater than that of the ventral, but the relative amount of growth of each lip is not certain. In early stages of closure the dorsal lip is alone concerned, as is also the case with ascidians; in later stages growth takes place from all sides. According to Pflüger the dorsal lip sometimes moves through an arc of 180° in the case of the frog, according to Roux 170°; Morgan estimates this movement at 120°, Kopsch at 75°, and H. V. Wilson at 72½°. In the ascidians there is no doubt whatever that the closure is due chiefly to the growth of the dorsal lip, though owing to the changing shape of the embryo it is difficult to estimate the angular amount of that growth.

In *Amphioxus* and the ascidians the growth of the dorsal lip occurs as rapidly in the middle as at the sides and there is therefore no indication of concrescence of lateral lips. At no stage during the closure of the blastopore in these animals is there any indication whatever of such concrescence, either in the form of a notch at the edge of the dorsal lip or of a seam along the middle of the neural plate. In *Cynthia* and *Ciona* I have seen every division of the cells of this lip up to an advanced stage and these divisions take place as rapidly

and uniformly along the mid-line as at the sides. Practically all investigators, who have studied the embryology of *Amphioxus* or the ascidians are in agreement upon this point, and if concrescence occurs among the amphibians, as is claimed by some investigators, though denied by others, it can only be said that in this respect the amphibians are very different from these other classes. The evidence that the amphibians do form such an exception is by no means conclusive, as Ziegler (1902) points out.

The question whether and to what extent there is an actual inrolling of cells from the outer to the inner layer in the closure of the blastopore is one which has been much discussed. In all three of these chordate classes an inrolling of cells at the margin of the blastopore has been repeatedly observed, but the relative number, the origin and the character of such cells are matters of dispute. Lwoff (1894) maintains that the entire dorsal lip of *Amphioxus*, inner as well as outer layer, is formed from ectoderm cells which are inrolled. All of these inrolled cells he counts as ectoderm and consequently concludes that the chorda and mesoderm are of ectodermal origin. The invagination of the endoderm is, in his opinion, the real gastrulation, whereas the turning in of the ectodermal cells is a coenogenetic process which has nothing to do with the formation of the enteron but is concerned only with the formation of chorda and mesoderm. This conclusion has been criticised by Samassa (1898), Klaatsch (1896), Morgan and Hazen (1900), *et al.*, on the ground that there is no sufficient evidence that the inrolled cells are ectodermal. With this conclusion, when extended to the ascidians, I heartily agree. Here the cells which are inrolled at the anterior border of the blastopore are chorda cells which are yolk laden and resemble endoderm and not ectoderm. The cells which are inrolled at the posterior lateral borders are mesenchyme and muscle cells and in histological structure are very unlike the ectoderm. While therefore agreeing with Lwoff that the chorda and mesoderm cells are inrolled (though from opposite portions of the blastopore lip in ascidians) I agree with his critics that these cells, judged by their lineage and histological character, are certainly not ectodermal.

6. *Neural Plate.*

In ascidians the neural plate material becomes segregated into six cells at the 44-cell stage; four of these cells lie in a transverse row at the anterior border of the dorsal hemisphere, just below the third cleavage plane and two of them lie just above this plane and therefore in the ventral hemisphere. The four dorsal cells lie just anterior to the four chorda cells from which they were separated at the sixth cleavage. Both the dorsal and ventral cells divide transversely, the former giving rise to an arc of eight cells the latter to one of four cells, and to these a single additional cell is added on each side making an arc of six neural plate cells in the ventral hemisphere. In subsequent divisions the neural plate increases much in length and its anterior portion also increases in breadth, but it is never more than eight cells wide in its posterior part. Soon after gastrulation begins the neural cells overgrow the chorda cells and thereafter cover the dorsal lip to its posterior

margin. During all this time the anterior margin of the plate reaches only about one-third of the way from the equator to the animal pole. The posterior margin of the plate reaches nearly to the hinder end of the embryo, and when the blastopore closes a pair of V-shaped folds runs forward from the region of the blastopore inclosing the neural plate between them. These neural folds then fuse from behind forwards thus converting the plate into a tube. Dorsal to the notochord the neural tube becomes solid; in the region in front of the notochord it retains its lumen. There is no nerve ring around the blastopore and probably none of the ectoderm cells around the posterior margin of the blastopore are added to the neural plate.

In *Amphioxus* and amphibians the neural plate is first recognizable about the the time of the closure of the blastopore. As in ascidians it arises in the outer layer of the dorsal lip and extends back as far as the blastopore, but whether its cells arise in close connection with the chorda and from both dorsal and ventral hemispheres as in the ascidians is unknown; furthermore, the distance of the anterior edge of the plate from the animal pole is unknown. The work of Kopsch (1900) indicates that in the frog the anterior margin of the plate is situated less than half the distance from the equator to the animal pole, and H. V. Wilson (1900) in particular has shown that the anterior part of the neural plate is formed from the black hemisphere, the posterior part from the white hemisphere,—a result which agrees precisely with my observations on ascidians. As is well known the method of closure of the neural tube in *Amphioxus* is peculiar, while the solid character of the hinder part of the tube is peculiar to the ascidians, but with these exceptions the later history of the neural plate and tube is essentially similar in all three classes.

7. *Chorda.*

In ascidians the substance of the chorda is segregated into a single transverse row of cells just posterior to the neural cells at the 44-cell stage, before there is a trace of gastrulation. These chorda cells are generally clearer and contain rather less yolk than the endoderm cells which lie immediately posterior to them. These four chorda cells divide transversely forming an arc of eight cells and soon thereafter a depression of the endoderm occurs posterior to this arc, which is the beginning of the gastrulation. These chorda cells are flanked on each side by the most anterior cells of the mesenchyme arc, the two arcs together forming the chorda-mesenchyme ring of Castle. The eight chorda cells then divide anteroposteriorly forming two rows of eight cells each. This plate of cells by shoving, by interdigitation and perhaps to a limited extent by folding, decreases in width and increases in length, the cells finally, in a late larval stage, becoming arranged in a single linear series. When they first arise the chorda cells are superficial in position, but in the overgrowth of the dorsal lip they are inrolled so as to lie in the roof of the gastrocoel. The posterior growth of the dorsal lip carries the entire chorda into the hinder half of the embryo, and it afterwards extends to the tip of the developing tail.

In *Amphioxus* the earliest stage at which the chorda has been positively identified is one when the blastopore is small and the embryo elongated. According to Hatschek it consists at this stage of a plate, about six cells wide, in the roof of the archenteron and extending along the mid-line of the dorsal lip throughout its entire length. This plate is narrower and longer than it is in the ascidians, but is otherwise much the same in appearance. The later history of the chorda is essentially the same in both forms. With regard to the origin of the chorda cells in *Amphioxus*, Morgan and Hazen (1900) have shown that the cells which are inrolled in the formation of the dorsal lip and some of which must take part in the formation of the chorda, are clear and contain less yolk than the endoderm cells. Whether these cells form at this stage a plate which is wider from side to side than it is long, as is true of the ascidian, is not known. Lwoff (1894) has also recognized the fact that the chorda cells are rolled in at the margin of the dorsal lip, and for that reason he regards them as of ectodermal origin.

In *Amphioxus* and in some amphibians the definitive roof of the enteron arises from cells which lie along each side of the chorda plate, and which finally grow under that structure and thus separate it from the gastric cavity; in the ascidians the chorda lies ultimately in the posterior part of the body where the gastric cavity is almost entirely lacking and there is no growth of endoderm cells under it to form the roof of the enteron. In most amphibians the chorda does not form a broad plate of cells, but is a narrow rod closely united ventrally with the endoderm, which forms the roof of the enteron, and connected laterally with the mesoderm. In these three groups of chordates the chorda plate is widest in ascidians and narrowest in amphibians. In all three it lies in the dorsal lip and is connected laterally with mesoderm (text figs. XXXVI—XXXVIII). The later history of the chorda is essentially the same in all three classes.

The question whether the chorda is of endodermal or of mesodermal origin is, as has been frequently said, one of definition of terms. Castle concludes that it is mesodermal because in *Amphioxus* and lower vertebrates it "is derived from a common fundament with what is universally regarded as mesoderm" and also because it "comes to occupy a position between the inner and outer layers of the embryo." On the other hand, the histological structure of the chorda cells in *Cynthia* and *Ciona* is much more like endoderm than mesoderm, and they are unquestionably derived from cells of the gastric endoderm at the 32-cell stage (fig. 117, 193). I believe that special importance should attach to the *structure* of the cells which form the chorda, and if this be accepted as a guide the chorda, at least among ascidians, should be regarded as endodermal.

8. *Origin of Mesoderm.*

The exact place and manner of origin of the mesoderm of ascidians can be recognized with the greatest certainty in the gastrula, cleavage stages and even in the unsegmented egg. The crescent, from which most if not all of the mesoderm arises, lies just below the equator of the unsegmented egg, and on the posterior

side, its arms extending forward to the second cleavage plane. It occupies this position throughout the whole of the cleavage, its substance becoming localized in a number of large rounded cells. In the gastrulation these cells are inrolled along the lateral-posterior borders of the blastopore, thus reducing the posterior portion of the blastopore to a groove and rendering the whole blastopore pear-shaped. No such appearance is found in *Amphioxus* or amphibians where the blastopore retains its circular form until a late stage; this may be interpreted as due to the fact that in these animals the mesoderm is not so largely developed at an early stage, but it furnishes no satisfactory reason for supposing that the mesoderm is not formed in corresponding positions in all three classes. We know that the neural plate and the notochord come from similar regions in all three, and it is most unlikely that the mesoderm arises from wholly different regions.

Hatschek's account of the origin of the mesoderm of *Amphioxus* shows some important resemblances to what occurs among ascidians. He found that running back on each side from the first appearing primitive segments was a mesodermal fold which led to a pair of pole cells in the ventral (posterior) lip of the blastopore. All recent investigators have denied the existence of these pole cells, and there can be little doubt that Hatschek was mistaken with regard to them. Even in the ascidian there are, strictly speaking, no pole cells in this region, nor anywhere else in the embryo. The cells which in the ascidian occupy the position assigned by Hatschek to the pole cells are the posterior mesenchyme cells. These cells form the middle of the crescent, and from them a band of mesoderm cells runs forward on each side, but these bands were not formed by the teloblastic growth of the posterior cells; on the contrary, their substance was localized in the crescent before cleavage began. However the non-existence of the pole cells of *Amphioxus* does not destroy belief in Hatschek's account of the mesodermal folds which run backward from the primitive segments to the blastopore. Several investigators have recognized such folds or bands, and their existence can scarcely be doubted. These bands have been seen only in older gastrulæ, and they here occupy a position which corresponds very closely with the mesenchyme bands in the ascidian gastrula. The separation of the muscle band from the mesenchyme band in the older gastrulæ of the ascidian (*v.* p. 69) is evidently a coenogenetic phenomenon, since nothing of this sort is known to occur elsewhere. If the mesodermal bands of *Amphioxus* are present in earlier stages than those in which they have been represented by Hatschek, and if they occupy the same relative position as in the ascidian they would surround the posterior border of the blastopore, and only by overgrowth of the dorsal lip and the narrowing of the whole blastopore would they come to lie alongside of the notochord. That mesodermal cells are present in the posterior lip of the gastrula of *Amphioxus* at an early stage is made probable by the observations of Lwoff, Klaatsch, Morgan and Hazen. Lwoff has found that the longitudinal musculature of *Amphioxus* arises along the hinder lateral parts of the blastopore, where it comes from ectodermal cells, as he thinks, which are inrolled. Klaatsch agrees with this and compares the "pole cell bands" of ascidians

with these mesodermal folds of *Amphioxus*. He has observed that in both ascidians and *Amphioxus* these cells are more rounded than other cells of the gastrula. Like Klaatsch, Morgan and Hazen find that around and within the ventral lip of the blastopore, during the early gastrula stages, there are frequently found small rounded cells which contain little yolk. They affirm that the form of these cells is not the result of cell division, as Samassa had assumed, but that they preserve their rounded form even in the resting stage.

Samassa (1898), however, says that in *Amphioxus* the origin of the mesoderm has no relation to the blastopore. The fact that the mesoderm has it growth zone at the caudal end of the embryo, in the vicinity of the blastopore, is, he says, a condition which it shares in common with all other organs of the embryo. In the face of the positive evidence adduced by Lwoff, Klaatsch, Morgan and Hazen this negative conclusion of Samassa's seem to me to lose much of its weight.

It seems probable from these accounts that mesoderm cells are present in the ventral lip of the early gastrula of *Amphioxus* just as in the ascidians, and that they give rise to the longitudinal mesodermal folds of later stages; it remains to be seen whether these mesoderm cells may not be traced back to a still earlier stage, comparable with the crescent in the ascidian egg (*cf.* text figs. XXVII–XXXII).

The origin of the mesoderm in amphibians is a much more difficult and complicated question and one into which I cannot enter fully here. It is generally believed, however, that in the frog's egg the cells which are to form the mesoderm are present when the dorsal lip first appears, and even prior to that time. They are the deeper layer of cells of the blastoporic ring and, therefore, surround the egg below the equator. Whether at their first appearance they surround the entire blastopore is not plain, but in later stages this is said to be the case. According to this view the notochord is a mesodermal structure differentiated out of the continuous ring of mesoderm surrounding the blastopore. There is here resemblance to the chorda-mesenchyme ring which is present in the ascidians and probably also in *Amphioxus*, but in the amphibians this ring appears to give rise at once to a sheet of mesoderm and not to mesodemal bands such as are found in *Amphioxus* and ascidians (text figs. XXXIII–XXXVIII).

On the whole it is probable that there is fundamental agreement between *Amphioxus* and ascidians in the place and manner of mesoderm formation, and though the amphibians differ in some important respects from the other two classes it is possible to interpret their method of mesoderm formation in the same general terms.

Referring to Rabl's (1892) "Theorie des Mesoderms," Samassa (1898), and Garbowski (1898) maintain that there is no "peristomal" mesoderm in *Amphioxus*, but that all the mesoderm is "gastral." If the view here taken is correct, all the mesoderm of this animal is at first peristomal while the gastral mesoderm is later derived from this. This is exactly the conclusion which has been reached by Davidoff (1891), and Castle (1896), with regard to the ascidian, a conclusion which I can

fully confirm from my own work. Furthermore, it is not improbable that the same thing is true of the amphibians. This is in confirmation of Rabl's view that the peristomal mesoderm is palingenetic, the gastral coenogenetic, and the suggestion is raised that in all these cases the gastral mesoderm is derived from the peristomal through the manner of overgrowth of the dorsal lip of the blastopore (text figs. XXXVI–XXXVIII).

Although I have made no special study of the subject, and cannot therefore speak with assurance, I have seen no evidence in favor of Van Beneden and Julin's view that enterocoels are present in ascidians as in *Amphioxus*; in this respect I am in accord with the more recent students of ascidian development (Davidoff, Castle).

From these comparisons I think it may be safely concluded that there are many fundamental resemblances in the early development of Tunicata, *Amphioxus* and Amphibia, and that in consequence of the early differentiation of the ascidian egg and embryo and because of the known cell-lineage of some of its important organs the development of these animals throws light upon the embryology of other chordate classes.

VII. THE ORGANIZATION OF THE EGG.[1]

It is interesting to observe how recent studies of development have led to the recognition of morphogenetic differentiations at earlier and earlier stages in the ontogeny; a dozen years ago the germ layers were the earliest differentiations of this sort which were generally recognized. It was in the attempt to determine the cellular origin of the germ layers that it became evident that the cleavage cells themselves were of morphogenetic value. Some of the differentiations of the cleavage cells could be traced back to the very first cleavage or even to the unsegmented egg; thus the study of cell-lineage led logically and unavoidably to the conclusion that the cleavage cells and even the unsegmented egg must be organized with reference to the parts and axes of the future animal.

For our present purposes the organization of the germ cells has reference only to such differentiations as are of direct value in the building of the embryo, in other words, such as are morphogenetic, and it may be held to include phenomena of polarity, symmetry and localization; it obviously includes other things also, such as regeneration and regulation, which are not, however, objects of investigation in this work.

A. Polarity.

Fifty years ago Remak showed that the pigmented hemisphere of the frog's egg gave rise to the cells of Von Baer's "animal germ-layer," while the white hemisphere gave rise to the "vegetative germ-layer." The middle of the ectodermal hemisphere has ever since been known as the animal pole, the middle of the endodermal hemisphere as the vegetative (vegetal) pole. It is a remarkable fact

[1] A more complete discussion of this subject, especially that portion of it which relates to experimental work, is reserved for a subsequent paper, only such matters being treated here as are the outgrowth of the observations recorded in the preceding pages.

that with a few possible exceptions, which are by no means well established, the polar bodies are formed at the animal pole of the egg in all cases. This is a fact of the most general occurrence and of the highest significance; it indicates that before or during the maturation of the egg there occurs a polar differentiation or localization of the egg substance of such a kind that in all cases the future ectoderm is formed at the maturation pole and the endoderm at the opposite pole.

The apparent exceptions to this rule are few in number and may be examined in some detail; they are limited to the eggs of certain insects, *Petromyzon*, copepods, *Ascaris*, echinoderms and ascidians. The only reason for supposing, as Korschelt and Heider (1903, pp. 545, 546) do, that the polar bodies are not formed at the animal pole in insects and in *Petromyzon* is that they here lie to one side of the pointed end of the egg; there is no proof that they do not lie at the middle of the ectodermal area. Häcker (1899) says that in the larger species of *Cyclops* "neither the place of formation of the polar bodies, the place of entrance of the sperm nor the position of the first cleavage spindle are preformed in the egg, but are secondarily determined by the position of the egg in the egg sack" (pp. 193, 194). However, this egg is one which is not easy to orient, and it has by no means been proven that the polar bodies do not form in this case at the middle of the ectodermal area. Even if the justice of all of Häcker's statements be admitted it has not been shown that the cleavage spindle may not rotate so as to cause the first and second cleavage furrows to pass through the maturation pole, as is usually the case. Such a rotation of the first cleavage spindle takes place in nematodes, and a somewhat similar rotation of the entire egg, after the formation of the first cleavage spindle, has been described by Bigelow (1902) in the case of *Lepas*, where it had previously been held that the first cleavage was equatorial. Häcker's observations do not show that the chief axis of the egg is not predetermined, and they certainly do not prove that the maturation pole and the ectodermal pole do not coincide.

In *Ascaris megalocephala*, Boveri (1887) observed that the second polar body is usually formed at some distance from the first "whether through wandering in the protoplasm or through a turning of the entire egg I could not determine" (p. 32). His figures (1888, pl. IV) show that the first cleavage furrow frequently passes through the point of attachment of the second polar body. The study of the cell lineage of *Ascaris* has shown that most of the ectoderm is segregated in one of the first two cleavage cells (the "primary ectoderm cell" of Zur Strassen, 1896). This would seem to indicate that in this animal the polar bodies do not lie at the middle of the ectodermal pole; however the relations of the maturation pole to the ectodermal pole and to the first cleavage are not clear in this case, and it may not be impossible that *Ascaris* may yet be found to conform to the general rule.

As for the echinoderms. Wilson (1895) supposed from indirect evidence that the maturation pole and the future animal pole did not usually coincide in *Toxopneustes*, and further that the chief axis of the egg was established only after

fertilization. However, the evidence in favor of this is not conclusive as Wilson admits. On the other hand, Boveri (1901) has shown in the most convincing manner that in *Strongylocentrotus* the polarity of the egg may be traced back to the ovocyte, and that this polarity determines the gastrular axis. It is, therefore, possible that in all echinoderms the polarity of the egg is predetermined in the ovary, and not after the maturation and fertilization, and that in all cases the maturation and ectodermal poles coincide.[1]

The most remarkable and apparently well established of these exceptions to the rule that the polar bodies are formed at the animal pole is that of the ascidians studied by Castle (1894, 1896), where the polar bodies were said to be formed at the vegetal or endodermal pole of the egg. However, this conclusion rests upon erroneous orientation, as I have shown in the preceding pages; in ascidians as in other animals the polar bodies are formed at the ectodermal pole. There are, therefore, no well established exceptions to this general law.[2]

In many cases it is known that the polar differentiation of the egg may be recognized while the egg is still in the ovary. Reference has just been made to the condition in *Strongylocentrotus* in which the pole of attachment to the ovarian wall becomes the maturation pole of the egg and the ectodermal pole of the larva. Boveri says that in all known cases the pole toward which the germinal vesicle is eccentric becomes the animal pole. In *Unio*, Lillie (1900) has demonstrated that it is the free pole of the egg which becomes the maturation and ectodermal pole, while the pole of attachment becomes the vegetal pole. In a number of gasteropods (*Limnæa*, *Succinea*, *Polygyra*, *Limax*, *Physa*, *Planorbis*, *Ancylus*) I have found that there is a marked polar differentiation of the egg in the ovary, the germinal vesicle being eccentric toward the free pole of the ovocyte. I have elsewhere (1903) shown reason for believing that in dextral snails the polar bodies are formed at the free pole and in sinistral snails at the attached pole of the ovocyte. In his work on *Cerebratulus*, Wilson (1903), found that the polar bodies were formed at the free pole of the ovocyte, and again in his recent paper on *Dentalium* (1904), he finds the side of attachment in the ovary represents the lower or vegetal hemisphere. We find then that the chief axis of the egg is very generally present in the ovocyte, and that the free side usually gives rise to the maturation and ectodermal pole, while the attached side becomes the vegetal pole; but in echinoderms and probably also in sinistral gasteropods these conditions are reversed, the side of attachment becoming the ectodermal pole.

In the gasteropods named above, I found it possible to recognize this polarity of the ovocyte at a very early stage; in general it coincides with the "organic axis" (Van Beneden), or the "cell axis" (Heidenhain) *i. e.*, the axis passing through the centrosome or sphere, and the center of the nucleus. This cell axis is a general

[1] However, Garbowski (1904) affirms that in *Asterias glacialis* the polarity of the egg is not determined even in the 8-cell and 16-cell stages, and that the blastomeres are equipotential up to the 500-cell stage!

[2] Wheeler (1897, p. 41–46) has discussed in an admirable manner the apparent exceptions to this law of polar differentiation and concludes that these exceptions are by no means well established.

characteristic of many, if not of all cells, and as it is present in all the cells of the cleaving egg, where it is preserved from one cell generation to another (*v.* Conklin, 1902), it may be considered to be a differentiation which is continuous from generation to generation. But while the cell axis determines the egg axis and this the gastrular axis, it is not necessary to suppose that in the early ovarian history of the egg one pole is composed of ectodermal substance and the other of endodermal. On the contrary, this is probably not the case. My observations on the living eggs of ascidians and snails leads to the view that it is not the extrusion of the polar bodies at one pole which causes that pole to become the ectodermal one, but rather that *it is the movement of the germinal vesicle with its contained clear protoplasm to one pole, and the spreading of this protoplasm at this pole, which is the determining factor. In short it is the localization of ectodermal substance at the maturation pole which causes that pole to give rise to ectoderm.* I shall return to this subject in the section on localization.

Whether other axes of the egg are predetermined before cleavage is in most instances unknown. In a few cases all the axes of the future animal are marked out before fertilization; for example, among insects and cephalopods, as is well known, it is possible to identify anterior and posterior, right and left, dorsal and ventral axes of the egg while it is yet in the ovary. In most cases, however, the only axis which is recognizable before fertilization is the chief axis of the egg. This is true of the ascidians, but here there are certain evidences, which will be presented in the next section, that the other axes are already established, though not directly recognizable until after fertilization.

B. Symmetry.

Van Beneden and Neyt (1887) suggested that bilateral symmetry may be characteristic of all cells of bilateral animals, and Lillie (1901) has expressed a similar view regarding the eggs of such animals. This hypothesis, if true, would materially simplify the problem of the earliest differentiations and localizations of the egg, but it is supported by little direct evidence; in fact, it is surprising that in most bilateral animals bilaterality appears so late in development. In most annelids and mollusks the egg and early cleavage stages are to all appearances radially symmetrical, and in many cases bilateral symmetry first appears with the formation of the mesentoblast cell, 4d. In echinoderms bilaterality is said to appear first in the gastrula stage; in *Amphioxus* during cleavage; in ascidians it appears immediately after fertilization and before the first cleavage; while in cephalopod and insect eggs it appears during the growth of the ovocyte in the ovary. Wilson has repeatedly expressed the view that characteristic differentiations, such as bilateral symmetry, arise at different periods of development in different cases, and it cannot be denied that the ocular evidence is in favor of this view. On the other hand, there are certain considerations which lead to the conclusion that bilateral organization may be present in the developing egg or embryo long before it is directly visible. For example, in *Neritina* there are two groups of granules in the proto-

plasm of the unsegmented egg, one on each side of the polar bodies. Blochmann (1882) observed that these granules were ultimately localized during cleavage in the right and left "Urvelarzellen." They therefore mark out a bilateral organization of the unsegmented egg, although the cleavage up to the time of the formation of the "Urvelarzellen" is typically spiral and radially symmetrical. In other gasteropod eggs, where these granules are lacking, not a trace of bilateral organization is visible before the formation of the mesentoblast cell; yet it can scarcely be supposed that the eggs of these gasteropods are so unlike those of *Neritina* as to be actually radially symmetrical as they appear to be. Rather it seems probable that the bilateral organization which appears in this one respect in the *Neritina* egg is characteristic of other gasteropod eggs also, though it does not usually become apparent until a later stage.

Crampton (1894) discovered that the cleavage of the egg in sinistral snails is reversed as compared with that of dextral forms. I have shown elsewhere (1903) that the inverse symmetry of sinistral snails is traceable to the inverse organization of the unsegmented egg. Of this fact there can be no doubt, though it is not yet certain how this inverse organization may have been produced. But an inverse organization of the egg, such as would produce inverse symmetry of the embryo and adult, implies of necessity a bilateral organization to begin with; it must be, therefore, that the eggs of these gasteropods are bilateral, though this fact is not directly evident.

In the ascidian egg the first appearance of bilaterality which I have been able to detect occurs soon after fertilization when the sperm nucleus moves toward one side of the egg which later becomes the posterior pole. One might, therefore, be inclined to consider that in this case the egg before fertilization was radially symmetrical, and that the chance movement of the sperm into one meridian determined the median plane of the embryo, were it not for the fact that all the movements of the sperm within the egg seem to be directed by the organization of the cytoplasm. The sperm always enters the egg near the vegetal pole, but the fact that the point of entrance is nearer that pole in some instances than in others shows that that point is not a fixed and constant one. After the sperm has penetrated the peripheral layer of protoplasm, and has turned so that its centrosome is directed forward in its movement through the egg it moves up to the equator of the egg in a path nearly parallel with the surface. Arrived at the equator, the upward movement ceases and the sperm nucleus and centrosome, after meeting the egg nucleus, turn in toward the center of the egg. These movements are of such a constant character that they cannot be the result of chance; they must be directed and probably by the cytoplasm of the egg. Furthermore, it seems probable from the evidence of such cases as figures 81 and 85 that *the sperm nucleus does not always take the shortest path to the equator as it should do if the egg were radially symmetrical and the median plane were really determined by the path of the spermatozoon. On the other hand, it sometimes apparently takes the longest path as if it must needs move in a certain meridian. This seems to indicate that*

the median plane of the embryo is not determined by the chance path of the spermatozoon within the egg, but rather that both the median plane and the path of the spermatozoon are determined by the structure of the cytoplasm.

Finally, in cases of normal or artificial parthenogenesis the median plane cannot be determined by the path of the spermatozoon. In eggs of this kind the establishment of bilateral symmetry must be held to be due to the structure of the egg itself or to environment, and whichever of these views may be accepted it follows that the path of the spermatozoon cannot be regarded as a general factor in determining the median plane of the embryo.

These and other similar considerations lead to the view that bilateral organization is frequently present in the egg before it becomes visibly manifest, and they lend support to the hypothesis of Driesch (1896) that the eggs of all bilateral animals are bilaterally organized, there being a "polar bilateral direction of particles" in the "intimate structure of the egg." *If this be true, the eggs, the cleavage stages and the blastulæ of annelids and mollusks, of echinoderms and Amphioxus are as truly bilateral as they are in the ascidians, though this bilaterality may be masked by a radial form of cleavage and by an apparently radial organization of the egg.*

I cannot pass over this subject without referring to the extensive work of Roux (1883, 1885, 1887, 1902, 1903) on the determination of the median plane in the frog's egg. This work is too widely known to require more than passing notice. By means of "localized fertilization," *i. e.*, the application of spermatozoa to any meridian of the egg, Roux has determined that the first cleavage plane passes through the entrance point of the spermatozoon and that the median plane of the embryo usually coincides with the first cleavage plane. He therefore considers that the median plane is in typical conditions, determined by the path of the spermatozoon. Moskowski (1902), on the other hand, holds that the first cleavage plane and the median plane of the embryo are determined by definite movements of the egg substance and not by the path of the spermatozoon. Castle (1896) believed that the plane of the first cleavage and the median plane of the embryo were determined, in the ascidians studied by him, by the place of entrance of the spermatozoon, the point of entrance marking the posterior pole; but since the point of entrance is near the vegetal pole, while the posterior pole lies near the equator. it is evident that the point of entrance cannot mark that pole. It is true that the protoplasm which gathers around the head of the sperm as soon as it enters the egg moves with the sperm to the posterior pole and there remains permanently, but the location of this protoplasm at this pole is evidently due to something other than the point of entrance of the spermatozoon. There is no question whatever that, in the ascidians, the path of the sperm within the egg coincides with the plane of the first cleavage and with the median plane of the embryo, but there is evidence, as I have shown, that this path is itself determined by the structure of the egg.

C. Cytoplasmic Localization.

1. *Localization in Cleavage Stages.*

That there is a specification and localization of those portions of the protoplasm of the egg which are destined in development to give rise to definite organs has been repeatedly affirmed and denied since His first propounded the doctrine of "organ forming germ regions" in 1874. At first this doctrine took the form of a mental projection of the early embryonic organs back upon the unsegmented egg. Later the study of cell-lineage showed that definite organs of the larva or adult arose from definite blastomeres, which in turn came from definite portions of the unsegmented egg. But although it was thus possible to map out the cleavage cells and the unsegmented egg into regions corresponding to certain organs of the embryo, it was not usually possible to show that these regions were visibly different from one another. Nevertheless the fact that certain blastomeres constantly gave rise to certain parts, and that other blastomeres developed very differently and gave rise to other parts, led students of cell-lineage generally to the view that there must be some protoplasmic difference between such blastomeres, though it might not be directly visible.

On the other hand were those who maintained that the protoplasm of the early cleavage stages was undifferentiated and that specifications which determined the fate of these cells arose only at a later period and under the influence of environmental or extrinsic conditions, such as mutual interaction between the cells, position in the developing embryo, *etc.* Such views were maintained on the ground of experimental work, especially that of Driesch, Hertwig, Morgan, Wilson and others, but it should not be forgotten that the experimental work of Roux furnished important evidence in favor of the independent differentiation, "*Selbstdifferenzirung*", of different blastomeres.

Thus while the study of cell-lineage showed conclusively that certain cells were destined in the course of normal development to give rise to certain organs and that the individual blastomeres were more or less differentiated from one another, the results of experimental work showed that in many animals individual cleavage cells were capable of giving rise to an entire embryo, and it was, therefore, affirmed by some investigators that these cells could not be differentiated for any particular end. Inasmuch as these facts of cell-lineage and of experimental embryology were well established, it was only possible to harmonize these discordant results by some form of interpretation. This was undertaken from two different standpoints: (1) It was affirmed that the early cleavage cells were not really differentiated for any specific end and that each might develop into any part of the embryo; if in any case certain parts or organs came from certain blastomeres it was due merely to the "continuity of development" (Hertwig, O., 1892).

(2) On the other hand, it was suggested that these discordant results as to the differentiation of the early cleavage cells might be explained by the fact that the eggs of different animals might differ in the time at which differentiations arise. In the eggs of echinoderms, *Amphioxus*, fishes and frogs, which had been

chiefly employed in experimental work, the cleavage was not known to be constant and differential in character; whereas in all forms the cell-lineage of which was known, the cleavage was both constant and differential. I therefore suggested (1897) that for the present it would be advisable to recognize two types of cleavage, a determinate type in which the blastomeres are differentiated from one another and are constant in their manner of origin and development, and an indeterminate type in which such differentiation and constancy are not known to occur. At the same time I was careful to state that this indeterminateness might be only apparent and not real, and "that the denial of a definite prospective value to each blastomere might rest upon the curious basis that no one had followed a single blastomere through the development" (1897, p. 191). In favor of such a distinction was the experimental work which had been done on the eggs of ctenophores and gasteropods; the cleavage in these animals is known to be determinate, and it was found that from a part of an egg only a part of an embryo would develop. In all cases constant and differential features appear sooner or later in the course of development, but if in some cases they appear late in the cleavage while in others they appear early this would explain the fact that in some species a whole embryo may be produced from one of the first two or first four blastomeres, whereas in other cases only a partial embryo results. Wilson in particular has defended the view that specifications arise at different times in different eggs, and that these differences in the time of specification may explain the different potencies of blastomeres or portions of the egg.

While it is entirely possible that differentiations may appear in some cases earlier than in others, experiments on the development of parts of eggs are no satisfactory test of the presence or absence of such differentiations as the eggs of echinoderms and ascidians well show. The echinoderms were supposed to present one of the best examples of an indeterminate form of cleavage; fragments of the egg or isolated blastomeres here give rise to entire embryos, and it was concluded that differentiations must appear in these eggs relatively late in development. But Boveri (1901) has shown that in *Strongylocentrotus*, and presumably in other echinoderms also,[1] a remarkable stratification of the egg, corresponding to the primary organs of the larva, appears at the time of the maturation of the egg. These observations have taught us more with regard to the actual differentiations of this egg, as contrasted with the potencies of its parts, than all the experiments which have ever been made. Again, the ascidian egg has one of the most determinate and morphogenetic forms of cleavage known and the differentiations of the various parts of the unsegmented egg are very great, and yet the experiments of Driesch (1895, 1903) and Crampton (1897) have shown that entire embryos may be produced from isolated blastomeres of this egg; such experiments apparently demonstrate the totipotence of the first four blastomeres of the ascidian egg,[2] but all the

[1] See foot-note, p. 89.

[2] Since this paper was written I have carefully studied the potency of individual blastomeres of the ascidian egg by the experimental method. My results, which will be published elsewhere, show that nothing resembling a normal embryo or larva is ever produced from any fragment of an egg which

experiments in the world could not have shown as satisfactorily as direct observation has done the remarkable cytoplasmic differentiations and localizations of this egg.

It seems, therefore, that this apparent conflict between the results of observation and of experiment on the early development of the egg, between the prospective tendency and the prospective potency of its various parts, can be harmonized neither by the claim that differentiations do not exist in the early stages of development nor by the assumption that differentiations appear earlier in some cases than in others.

(3) It seems rather that the true explanation of this discrepancy is the one originally suggested by Roux (1892, 1895), *viz.*, that there is a difference in the regenerative or regulative capacity of different ova and that in the experimental studies referred to we are dealing with *indirect development or regeneration*, as contrasted with *direct or normal development*. Just as some adult forms show little capacity for regeneration or regulation while others of equally complex differentiation show this power in a high degree, so it seems that the capacity for regulation shown by eggs is more or less independent of the degree of their differentiation. To all appearances the ascidian egg is more highly differentiated than those of mollusks or ctenophores, and yet the former has a much higher regulative capacity than the latter. *If this view of the relative independence of differentiation and regulation be correct the conflict between the results of cell-lineage and of experimental embryology disappears, for the prospective tendency or the actual differentiation of a blastomere and its prospective potency deal with two distinct things.*

2. *Localization before Cleavage.*

The phenomena of germinal localization have heretofore been studied for the most part during the cleavage and subsequent periods of development; only within the last few years has this study been extended to the egg before cleavage. Nevertheless the brilliant researches of Driesch, Lillie, Boveri, Fischel, Wilson and Carazzi in this field have already yielded most important results, and are full of promise for future work. In some cases this localization of different kinds of protoplasm or of organ-forming substances has been directly observed, in other cases it has been inferred from the results of experiment, but in many instances both observation and experiment lead to the conclusion that the morphogenetic processes begin before cleavage. The work of Lillie on *Unio* (1901) and *Chætopterus* (1902), and especially experiments of Fischel (1897, 1898, 1903) on the ctenophore egg, and of Wilson (1903), and Yatsu (1904) on the nemertine egg have shown that definite regions of the unsegmented egg give rise to definite organs or regions of the embryo.

Apart from the early separation of protoplasm and yolk which occurs in many yolk-laden eggs, localization of visibly different kinds of protoplasm in the unsegmented egg has been observed in relatively few cases. Among the earliest observa-

does not include the whole of the right or left half. *Individual blastomeres produce rounded masses of* ***cells but have no power to give rise to muscle, chorda, neural plate or sense organs, if they do not contain*** *those portions of the egg which normally give rise to these parts.*

tions of this sort are those of Robin (1875) and Whitman (1878) on the eggs of leeches. Here peculiar aggregations of protoplasm occur at the two poles of the egg, after maturation and fertilization, which have been called "polar rings." Vejdovsky (1888) discovered that these polar rings arise in *Rhynchelmis* from a peripheral layer of brown protoplasm, which has a great affinity for stains. The substance of this layer collects at the two poles of the egg after maturation and fertilization and thus constitutes the polar rings. During the cleavage most of this substance is segregated into the large posterior macromere of the 4-cell stage, and it ultimately passes into the mesomeres (probably the first and second somatoblasts of Wilson). Nevertheless other portions of this protoplasm go into the micromeres; in fact it forms "the general material for the building of the body, with the exception of the intestinal epithelium" (Vejdovsky, 1888, p. 123). Polar rings have also been observed by Foot (1894, 1896) in *Allolobophora*, and their method of formation in this form has been determined in a most careful and satisfactory manner; this work will be discussed more fully in the next section on the genesis of egg organization.

One of the most remarkable cases on record of the localization of visibly different kinds of oöplasm is found in *Myzostoma glabrum* in which Driesch (1896), and more recently Carazzi (1904), observed two conspicuous zones of protoplasm in the egg before maturation, an upper one which is of a redish tint and a lower one which is green. During the maturation of the egg the upper zone differentiates into two, an upper red zone and an equatorial colorless one. According to Driesch (1896, p. 120) the red zone gives rise principally to the substance of the micromeres (ectoderm), the clear zone to endoderm, and the green one to the substance of the somatoblasts (ectoderm and mesoderm).

Another case of visible localization of the substances of the unsegmented egg was observed by Boveri (1901) in the ovocyte, egg and larva of *Strongylocentrotus lividus;* here before maturation and fertilization the surface of the egg is covered by a uniformly distributed red pigment; after maturation this gathers into an equatorial zone leaving an area of clear protoplasm at the upper pole and another at the lower one. Later development shows that the upper clear cap gives rise to the ectoderm, the red zone to endoderm and the lower cap to mesenchyme.

A visible localization of differently colored substances in the unsegmented egg also occurs in fresh water snails belonging to the genera *Physa*, *Planorbis* and *Limnæa*. In these animals I have found (Conklin, 1903) that a clear cap of protoplasm appears at the upper pole during maturation and then gradually spreads over the upper hemisphere of the egg; the upper hemisphere thus becomes milky-white in the living egg, while the lower half remains yellow. I have followed these white and yellow substances through the development and find that the white substance gives rise to the ectoderm, the yellow to the mesoderm and endoderm.

Quite recently Wilson (1904) has observed in *Dentalium* a localization of unlike substances in the unsegmented egg and by a series of experiments he has shown the part which some of these substances take in the formation of certain organs of the larva. As in the case of *Strongylocentrotus* there is here an accumulation of

clear protoplasm at each pole of the egg with a broad pigment band around the equatorial region. The clear polar areas, the lower of which forms a prominent lobe, Wilson regards as comparable with the "polar rings" of leeches and oligochætes.[1] In the course of development the upper white area is allotted to the three quartets of ectomeres; the middle pigmented zone is mainly allotted to the four basal entomeres, while the lower zone passes mainly into the first somatoblast (2d), and possibly also into the second somatoblast (4d) and the left posterior micromere (3d). This work is the most complete and important which has yet been done on the subject of cytoplasmic localization and it firmly establishes the fact that different substances and areas of the unsegmented egg are causally related to different organs and parts of the larva.

It is doubtful whether any other case of cytoplasmic localization hitherto reported is more remarkable than that which has been described in the preceding pages for the ascidian egg. The most striking features of this localization are the great differences in the substances localized, the manner in which this localization is accomplished and its bilateral character.

(1) The first of these features is the result of the different pigments which are associated with the different kinds of protoplasm, and which mark out as on a map the various germinal areas of the egg. In *Cynthia* the pigment in the peripheral layer of protoplasm is yellow, the yolk is a blueish gray, while the protoplasm which escapes from the germinal vesicle is colorless. Not the pigment but the protoplasm with which it is associated is of differential value, for the pigment may differ most remarkably in different genera of ascidians, but the organs which arise from similar areas are in all cases similar. What has been said of the pigment may also be said of the yolk; this inert substance is not in itself of differential value, but it lies in a definite region of the egg and probably in a particular kind of protoplasm, which it marks out as the yellow pigment does the peripheral layer.

Of these three kinds of protoplasm the yellow (mesoplasm) goes almost entirely into the musele and mesenchyme cells, though a small portion of it may be found around the nuclei of other cells, the clear protoplasm (ectoplasm) is chiefly distributed to the ectoderm and the gray yolk-laden protoplasm (endoplasm)[2] to the endoderm, though here also some of these substances are distributed to all the cells. It is not to be supposed that these three kinds of protoplasm are the only ones present in the egg, rather it is probable that others are present which are not visibly distinguishable. In fact, soon after the cleavage begins, it is noticeable that the protoplasm in the dorsal part of the crescent is a fainter yellow than that in the ventral part, while from the time of the fertilization onward the middle of the crescent is marked by a small area of clear protoplasm (*v.* p. 21); the deeply pigmented

[1] Several years ago I suggested (Conklin 1897, p. 39) that the yolk lobe ("polar lobe," Wilson) was comparable to the polar rings of leeches.

[2] It should be observed that these names are given with reference to the part which these different portions of the oöplasm play in the development of the animal; the peripheral layer of the ovocyte, which would be called *ectoplasm* if the ovocyte alone were under consideration, is *mesoplasm* when regarded from the standpoint of its fate in development.

portion of the crescent gives rise to the muscle cells, the lighter or clearer portions to mesenchyme. Inasmuch as the protoplasm which enters into the muscle cells and mesenchyme is localized with such definiteness in the unsegmented egg it can scarcely be supposed that the substances which are to give rise to the neural plate and notochord are not also definitely localized though they may not be directly visible.[1] If this presumption is correct the visibly different organ-forming substances are by no means the only ones present.

(2) The striking effect of this cytoplasmic differentiation is heightened by the manner in which localization takes place. The downrush of the peripheral layer of yellow protoplasm to meet the entering sperm, the subsequent movement of this protoplasm together with the sperm nucleus to the posterior pole and the formation there of the crescent, the migration of the clear protoplasm to the lower pole, thence to the posterior pole and then to the center of the egg.—these phenomena are so evident and they occur so rapidly that they strike the observer with amazement.

(3) Finally the bilateral character of this localization is most notable. In all other recorded cases of cytoplasmic localization the various substances become arranged in zones around the chief axis of the egg and the symmetry is apparently radial; here the early stages of localization are also of this sort, and the gray upper pole, the clear middle zone and the yellow lower pole of the *Cynthia* egg immediately after fertilization are not unlike the localizations in the eggs of *Myzostoma* or *Strongylocentrotus*, but in the ascidian this apparent radial symmetry gives place almost immediately to a marked bilateral symmetry which is brought about by the movement of the protoplasm from the lower hemisphere to the posterior pole and the formation there of the crescent.

Certain fundamental resemblances which run through all these cases of cytoplasmic localization are so striking that they scarcely need any emphasis here. The existence in the unsegmented egg of a peripheral layer of protoplasm which is clearly distinguishable from the remainder of the egg is a phenomenon of very wide occurrence. *In most of the cases just named this peripheral layer aggregates at one or both poles of the egg after fertilization, and in animals belonging to phyla as far apart as annelids, echinoderms, mollusks and chordates the substances at the upper pole give rise to ectoderm, those at the lower pole to mesoderm, while the endoderm arises from the region intermediate between these two. Although many differences appear in the later development of these animals they do not detract from the value of these fundamental resemblances which apparently afford a sound basis for a comparative morphology of ova.*

[1] Since this was written I have been able to distinguish the chora neural-plate substance as early as the 2-cell stage; it is the light gray protoplasm at the anterior border of the dorsal hemisphere (figs. 28, 32 *et seq.*) Photomicrographs of living egg of this stage will be published soon in which this substance is clearly shown.

D. Genesis of the Organization of the Egg.

It is probable that the differentiations of egg cells, of blastomeres, and possibly of all types of cells, are reducible to two fundamental processes:—(1) the genesis of unlike substances, and (2) the localization of these substances in definite parts. Few observations or experiments have been made on the former of these processes and probably no other problem of development would better repay a thorough investigation; the localization problem has been approached from many sides and has yielded results of great interest and importance.

It is a significant fact that localization in the unsegmented egg takes place in so many cases at the time of maturation and fertilization. This is the case in certain ascidians, fresh-water snails, nemerteans and echinoderms; in *Myzostoma* and *Dentalium* the two poles of the egg are dissimilar while the egg is still in the ovary, but here also active localization goes on during maturation. In ascidians and fresh-water snails it is not possible to determine whether the movements which lead to localization are dependent upon the maturation or upon the fertilization of the egg, since as yet it has not been possible to separate experimentally these processes; they certainly seem to be associated with the entrance of the spermatozoon, but since the maturation does not here occur until after the fertilization, it is not possible to determine with certainty the relative importance of these two processes in causing localization. In *Strongylocentrotus* the movements which lead to the formation of the red pigment zone occur after the extrusion of both polar bodies and before fertilization; in this case therefore the localization is associated with the maturation.

1. *Role of the Nucleus in Differentiation; Cytoplasmic Organization and the Nuclear Inheritance Theory.*

The localization which is effected in the ascidian egg upon the entrance of the spermatozoon is by no means the initial localization in this egg. In the ovocyte before maturation and fertilization the mesoplasm, which later give rise to the mesoderm, exists as a peripheral layer of protoplasm, the ectoplasm, which in later stages is chiefly distributed to the ectoderm, is in large part contained within the germinal vesicle, while the yolk-laden portion of the egg, the endoplasm, which later passes largely into the endoderm, is nearly central in position (figs. 61, 76). At an earlier stage neither the peripheral layer nor the yolk are recognizable as such; the cell body is composed of granular deeply-staining protoplasm, and around the nucleus is a distinct granular mass, the "yolk matrix" of Crampton (1899). In the very young ovocyte this granular mass is situated chiefly on one side of the nucleus, and frequently contains at its center a large granule, surrounded by a clear area, which I take to be the centrosome; the granular mass surrounding this is accordingly sphere material or archoplasm.

In the growth of the ovocyte the sphere material enlarges and spreads around the nucleus, forming the yolk nucleus or matrix; it then begins to disintegrate into

granules or larger masses,[1] as described by Crampton, which wander out into the cell body. Crampton has observed that these granules give rise to the yolk spherules which first appear in the protoplasmic ground substance around the nucleus, leaving the peripheral layer of the egg free from yolk.

I am of the opinion that the peripheral layer also contains portions of the archoplasm or sphere material; the staining reactions of this layer are like those of the archoplasm; in the disintegration of the sphere flocculent masses of archoplasm pass into this layer; finally, comparison with other forms favors this view. The careful observations of Foot (1896) on the yolk nucleus and polar rings of *Allolobophora* show that in this animal the polar rings may be traced back step by step to a substance in the vicinity of the nucleus of the very young ovocyte, which Foot identifies with archoplasm. In the later stages this substance becomes distributed throughout the cell and forms a more or less irregular peripheral layer; finally the substance of this layer aggregates at the two poles of the egg to form the polar rings, as previously described.

Among gasteropods the sphere material is largely of nuclear origin, containing nuclear sap and dissolved oxychromatin, which have escaped from the nucleus during the period of mitosis (Conklin, 1902); if the same be true of the ascidians both the peripheral layer of protoplasm (mesoplasm) and the yolk (endoplasm) contain elements which were ultimately derived from the nucleus at the last ovogonic division.

The clear protoplasm (ectoplasm) which is apparent in the egg after maturation, and which, in the course of development, passes mainly into the ectoderm is largely contained within the nucleus of the ovocyte. In the first maturation division an extremely large quantity of nuclear sap, containing an unusual amount of dissolved oxychromatin, escapes into the cell body where it can be recognized as an area of clear protoplasm. This clear protoplasm can be followed through a large part of the development, both in ascidians and in gasteropods. In the latter particularly this clear nuclear plasm is plainly visible in the living egg. It forms a fusiform or columnar area around the first maturation spindle, and after the formation of the polar bodies it flattens out at the surface of the egg, forming first a cone, then a lenticular mass, and finally a cap of clear protoplasm. This cap extends down over the egg to a region a little below the equator, and finally during cleavage it is largely localized in the three quartets of ectomeres.

In the ascidians the later history of this nuclear plasm is not so easily followed as in the gasteropods, owing to the presence of a peripheral layer of mesoplasm, and to the fact that its movements here are more extensive and complicated. In *Cynthia* it flows to the lower pole along with the yellow mesoplasm, then it moves with the sperm nucleus to the posterior side of the egg and finally to its center. Here it surrounds the cleavage spindle, and at the close of the first cleavage moves toward the animal pole so that the larger part of it comes to lie in the upper hemisphere. In subsequent divisions it surrounds all the nuclei though the most of it goes into the ectodermal cells as in the case of gasteropods.

[1] These fragments of the yolk nucleus are larger and more easily seen in *Molgula* than in either *Ciona* or *Cynthia*.

This truly remarkable condition in which considerable portions of the cytoplasm are traceable to the nucleus is of the utmost theoretical importance. From all sides the evidence has been accumulating that the chromosomes are the seat of the inheritance material, until now this theory practically amounts to a demonstration. On the other hand, all students of the early history of the egg have observed that the earliest visible differentiations occur in the cytoplasm, and that the position, size and quality of the cleavage cells and of various organ bases are controlled by the cytoplasm. However, *in the escape of large quantities of nuclear material into the cell body and the formation there of specific protoplasmic substances we have a possible mechanism for the nuclear control of the cytoplasm, and when, as in the case of the ascidians and fresh water gasteropods, these substances are definitely localized in the egg, and can be traced throughout the development until they enter into the formation of particular portions of the embryo, a specific mechanism for the nuclear control of development is at hand, and the manner of harmonizing the facts of cytoplasmic organization with the nuclear inheritance theory is clearly indicated.*

Of course substances which enter the nucleus and contribute to its growth must reach it through the cytoplasm, but this does not signify that the same substances are given back to the cytoplasm as are taken up from it; on the contrary we know that some of the substances which escape from the nucleus (*e. g.*, oxychromatin) are not identical with those which enter it. Considering the necessity of the nucleus in assimilation and regeneration, it seems most likely that differentiations of the cytoplasm proceed in the first instance from the nucleus; and, indeed, in the case of the egg cell, some of the important cytoplasmic substances can be actually seen to come from the nucleus. This does not indicate that these substances exist from the beginning in the nucleus; on the contrary there is direct and visible evidence that they arise epigenetically. Such epigenesis, however, does not signify lack of primary organization; on the other hand all the evidence favors the view that back of the organization of the cytoplasm is the organization of the chromosomes, which is definite, determinate and primary.

What has been said with regard to the genesis of the different substances of the cytoplasm applies in the main to their localization. It is evident that this localization is progressive, and that it arises epigenetically. But though we may push back this localization to earlier and earlier stages and to simpler and simpler forms we cannot entirely do away with it, even though it may be traced to polarity and chemotropism. Some basis of localization must be present in the earliest stages of the oögenesis, but this may possibly be little more than is found in the body cells in general. It does not seem improbable that the differentiations and localizations of the ovocyte and of the tissue cells are comparable in their manner of origin. The most remarkable difference between the two is that the tissue cells having reached the limit of their differentiation are incapable of further development whereas the egg cell having reached the limit of its differentiation in the ovary may, under the conditions of a free cell, begin another series of differentiations which lead to the production of an organism.

2. *Factors of Localization.* a. *Cytoplasmic Movements.*

Undoubtedly the most important of all the localizing factors so far recognized are cytoplasmic movements. Such movements have been observed in unsegmented eggs as well as in the cleavage cells, and they are generally associated with localization of unlike substances and frequently with cell division. The importance of such movements in the differentiations of the egg I first recognized in *Crepidula* (1899), where the movements of the cytoplasm during cleavage are very extensive. In the ascidian egg, on the other hand, these movements are most pronounced in the period between the fertilization and the close of the first cleavage. In both the ascidian and gasteropod these movements are definitely directed and bring about a constant and typical form of localization of the materials of the egg.

The fact that these movements are definitely directed shows that they are dependent upon a constant organization of the cell; their immediate cause is unknown. So far as I have observed, these movements always begin soon after the disappearance of the nuclear membrane and the consequent escape of nuclear material into the cell body. In the case of the gasteropods, I have suggested (1902) that one of the characteristic movements of the telophase of division is due to the affinity of the sphere material for oxygen. After the formation of this sphere material, during each cell division, it moves to the surface of the cell and as nearly as possible to the animal pole. If, however, the eggs be placed in water, from which the oxygen has been removed by boiling, this movement to the surface does not take place. In the ascidian the entrance of the spermatozoon seems to be the inciting cause of the movement. The peripheral protoplasm (mesoplasm) rushes down to the point of entrance and masses around the spermatozoon; then when the latter moves toward the posterior pole this protoplasm goes with it and is thus gathered into the crescent; finally, when the sperm nucleus moves in toward the centre of the egg the larger part of this protoplasm remains at the surface, while a small portion of it is drawn in with the sperm toward the center of the egg. In these movements, as well as in the subsequent ones during cleavage, the mesoplasm remains near the surface of the cell and in this respect resembles the sphere substance of the gasteropod egg. The flowing of the protoplasm to meet the entering spermatozoon is a phenomenon of rather general occurrence. In most cases this leads only to the formation of a small protoplasmic field around the sperm and sometimes to the formation of an entrance cone; in the ascidian practically all the protoplasm of the egg takes part in this movement leaving the maturation spindles with only a trace of protoplasm around them. This withdrawal of the protoplasm from the animal pole may be associated with the fact that there are no centrosome or asters in the maturation spindles, whereas there is a large centrosome and aster in connection with the sperm nucleus. Certainly the clear protoplasm is usually found in the region of the asters. What the exact nature of this attraction between the protoplasm and the spermatozoon is, is not known, but the important point here is that the cause of the remarkable movements of the protoplasm which follow the ferti-

lization of the ascidian egg is not unique, and that the whole movement is peculiar only because of its extent and the definite manner in which it is directed.

The movements which take place during cleavage are in part merely the general movements which accompany cell division and in part they are of a localizing character. In the former class are the vortical movements which probably cause the separtion of the chromosomes and the division of the cell body (Conklin, 1902); in the latter are such movements as that which occurs at the close of the first cleavage by which the clear protoplasm is carried from a central position into the upper hemisphere of the egg. After the cleavage has begun the localizations due to movement are strictly limited to the individual cells, no movements of a localizing character occurring through cell walls.

b. *Cell Division as a Factor of Localization.*

This brings us to the much discussed question of the role of cell division in development, and more particularly of the influence of cell division on phenomena of localization. There can be no doubt that in many eggs the localization which begins before cleavage continues during that process.

To a certain extent cleavage may be regarded as a localizing factor, but its importance in this respect is certainly far less than that of the active movements just described. Inasmuch as localizations may take place in the absence of cleavage or before it begins, and since many cleavages are non-differential it is evident that there is no close nor necessary connection between the two. Furthermore the cleavage planes do not always coincide with the lines of localization; this is shown especially well in the ascidian, where the localization in the unsegmented egg is particularly distinct. Thus the cleavage planes do not follow closely the boundaries of the crescent; the first and second cleavage planes are placed symmetrically with reference to the crescent, but they do not coincide with any of its boundary lines. The third cleavage plane lies above the upper border of the crescent when first formed; later the crescent extends up to the equatorial plane so that the cleavage plane and the upper boundary of the crescent coincide (fig. 31, 32). The fourth cleavage cuts off the median posterior crescent cells from the lateral ones, but leaves an area of yolk in both of these cells (fig. 37). In the median posterior cells this is a small wedge-shaped mass of yolk which is later covered and obscured by the yellow crescent substance (fig. 39). The neural plate arises on the anterior side of the egg from cells which lie both above and below the equator, or plane of the third cleavage; these neural plate cells are rich in protoplasm, and correspondingly the area from which they arise is richly protoplasmic. The third cleavage cuts right through this protoplasmic area leaving a portion of it above and a part below the equator. In the 8-cell and 16-cell stages the anterior dorsal cells contain both neural-plate and chorda substance; the portion of each of these cells turned toward the equator is protoplasmic, that turned toward the vegetal pole yolk-laden ($A^{6.2}$, $A^{6.4}$, figs. XVII, XIX, 116, 117). At the next cleavage these two portions are separated, the upper protoplasmic part becoming the neural

plate cells, $A^{7.4}$ and $A^{7.8}$, while the lower yolk-laden part becomes the chorda cells, $A^{7.3}$ and $A^{7.7}$. The chorda-neural substances are thus contained in the same cells until the sixth cleavage, though their substances are distinct at a much earlier period. Still other instances might be cited to show that the planes of localization and the planes of cleavage do not always coincide. This is in part due to the fact that the boundaries of the different kinds of germinal material, *e. g.*, the yellow protoplasm of the *Cynthia* egg, are not as sharp as are the boundaries of the cells, and consequently the cleavage furrows cannot precisely separate different kinds of germinal material. Nevertheless the cleavage planes are, under normal conditions, constant in position and character and bear a constant relation to the planes of differentiation. But that this relationship is not a casual one is further indicated by experimental studies on cleavage in which the position of the cleavage furrows may be altered without altering the localization of germinal materials or the typical form of development. Therefore the factors which determine localization and those which determine the form of cleavage are more or less independent.

All of these facts speak unmistakably for the view that localization is more fundamental than cleavage as Whitman (1893) has so ably maintained, and that such correspondence as may exist between the two is of secondary origin and of minor importance. Nevertheless the extreme constancy of cleavage forms shows that we have here a phenomenon, which if of secondary importance to germinal localization, is still of real significance. I have shown that in *Crepidula* the cleavage is a localizing factor, though secondary in importance to protoplasmic movement, and it seems probable that Wilson (1903) is right when he argues that the relative isolation produced by cleavage gives opportunity for the increase of any initial differences which may exist in the cells at the time of their formation.

Finally it must be concluded as a result of both observation and experiment that the type of cleavage is less constant and less fundamental than the type of localization, but that cleavage may itself be a factor in the progressive specification of cells (*cf.* Wilson, Lillie, Conklin, *et al.*).

E. Types of Germinal Localization; Evolution of Types.

The wonderful resemblances in the germinal localization of annelids and mollusks, as shown especially in the cleavage, have been repeatedly commented upon. Furthermore this localization is for shadowed in the egg before cleavage begins, and this suggests the inquiry as to whether the resemblances between types of localization grow closer as one approaches the ovocyte, and whether the manner as well as the results of localization are comparable in the different types. At present our knowledge of the localization in these earliest stages of development is very incomplete, and a comparison can be drawn only between annelids, mollusks, ctenophores, echinoderms, ascidians and possibly nemerteans and nematodes.

In most of these phyla a peripheral layer of protoplasm is present before maturation, which after maturation and fertilization collects at one or both poles of the egg; also with the possible exception of the ctenophores and nematodes,

there is remarkable uniformity in the localization of the substances of the germinal layers in all of these groups, the ectodermal substances being located in the upper hemisphere, and the endodermal and mesodermal in the lower hemisphere of the egg. But in the localization of important organ bases there are many differences between these phyla.

1. *Annelid-Mollusk Type.*

The pattern of localization in annelids and mollusks is very similar during the cleavage stages and, so far as can be judged from present knowledge, it is much the same in the unsegmented eggs of these two phyla. The fact that the ectoderm, mesoderm and endoderm come from cells which are identical in origin, position and number; that the umbrella, prototroch, cerebral ganglion, sub-œsophageal ganglion, mesodermal bands, blastopore, stomodæum and intestine come from corresponding region of the egg in the two groups, these facts speak strongly in favor of the regional homologies of the eggs of these phyla, whatever may be thought of their cell homologies (Conklin, 1897; Child, 1900). But regional homologies as well as cell homologies must be based upon similarities of germinal localization, and we would, therefore, be justified in concluding that the types of localization were similar in the unsegmented eggs of annelids and mollusks even in the absence of any direct knowledge upon that subject. But the experiments of Crampton (1896) on *Illyanassa* and of Wilson (1904) on *Dentalium* as well as the observations of Lillie (1899, 1901) on *Unio*, and my own observations on localization in the eggs of *Crepidula*, *Physa*, *Planorbis* and *Limnæa* furnish considerable information as to the time, the manner and the nature of localization in the molluscan egg during and before cleavage, while numerous works on the cell-lineage of the annelids as well as the observations of Wheeler (1897), Driesch (1896) and Carazzi (1904) on the unsegmented egg of *Myzostoma* show that the nature of localization is here very similar to that found in the mollusks.

In all of these cases the only formative substances which are directly recognizable before cleavage are those of the future germ layers. In the main the ectodermal substances are located in the upper hemisphere and the endodermal in the lower, though Wilson (1904) has found that the apical organ does not form in the larva of *Dentalium* when the polar lobe at the vegetal pole is removed. The mesodermal substances are also located in the lower hemisphere, and since the primary mesoderm cell (4d) always come from the left posterior macromere of the 4-cell stage and from the posterior blastomere of the 2-cell stage it may be inferred that immediately before cleavage it lies posterior to the vegetal pole; whether it may be located exactly at the vegetal pole in still earlier stages and then later shift to the posterior side, as in ascidians, cannot be determined at present.

When a polar lobe is present the mesodermal substance is probably located in it. Crampton (1896) found in *Illyanassa* that the mesoblast cell (4d) did not form when the lobe had been removed; Wilson (1904) holds that in *Dentalium* the substance of the lobe is allotted to both the first and second somatoblasts (2d and 4d), and that its size is proportional to the size of those cells and of the parts to which

they give rise. He calls particular attention to the fundamental resemblances between the eggs of *Dentalium* and of *Myzostoma* in the matter of the polar lobe and the "pillar of protoplasm." Furthermore this lobe is comparable to the polar rings of leeches and oligochætes. Such a lobe, although present in some annelids and mollusks, is not present in all of them, and this would at first thought seem to mark some important difference in localization. But the presence or absence of such a lobe probably indicates no fundamental dissimilarity in the localization, but rather variations in the surface tension and fluidity of different eggs. Although there are many interesting differences between various annelids and mollusks in the size of the polar lobe, of the blastomeres and of larval organs, these differences mark variations in the proportions of parts rather than in the type of localization. In all known cases among annelids and mollusks corresponding organs arise from corresponding regions of the egg.

It may be concluded also from the work of Wilson (1903) and Yatsu (1904) on *Cerebratulus* that the character of the localization in the nemertine egg is essentially like that of the annelid and mollusk, though many of the details of localization are less accurately known in this case than in the others named.

2. *Ctenophore Type.*

If Fischel (1903) is right regarding the localization which he ascribes to the unsegmented ctenophore egg there is one fundamental difference between the ctenophore and other animals whose types of localization are known. On the authority of Metschnikoff he derives the mesoderm (somewhat doubtfully it must be said) from the micromeres at the upper pole of the egg, and consequently in his fig. 21 (p. 708) he localizes the mesodermal material at the upper pole of the unsegmented egg. A zone below this, reaching to the equator or a little lower, represents the ectodermal substance, and in it is located the material for the ciliated plates. At the lower pole and in the central part of the egg is the material substratum of the endoderm. In all other well established cases the ectodermal substances lie near the animal pole, while the mesodermal and endodermal substances lie near the vegetal pole. Inasmuch as an apical sense organ is formed at the animal pole in ctenophores in much the same way as in annelids, mollusks and nemerteans, it is difficult to resist the conclusion that the localization of the ectodermal, mesodermal and endodermal substances in the ctenophore egg will ultimately be found to be similar to that which prevails in other types.

3. *Echinoderm Type.*

The form of localization in the echinoderm egg, as shown by Boveri's (1901) work on *Strongylocentrotus*, is in many respects similar to the annelid-mollusk-nemertean type. In this case, however, the mesoplasm is located at the lower pole of the egg and is sorrounded by an equatorial zone of endoplasm, whereas in annelids and mollusks, after the first two cleavages, the endoplasm lies at the lower pole, and the mesoplasm on the posterior side of this pole, and in one only of

the first four blastomeres. Whether the mesoplasm lies on one side of the vegetal pole in the unsegmented egg of annelids and mollusks cannot be affirmed on direct evidence, but it seems not unlikely that this is the case. If this be true there is here a difference between echinoderms and annelids or mollusks, in the form of localization, though it is by no means impossible to derive one type from the other.

4. *Ascidian Type.*

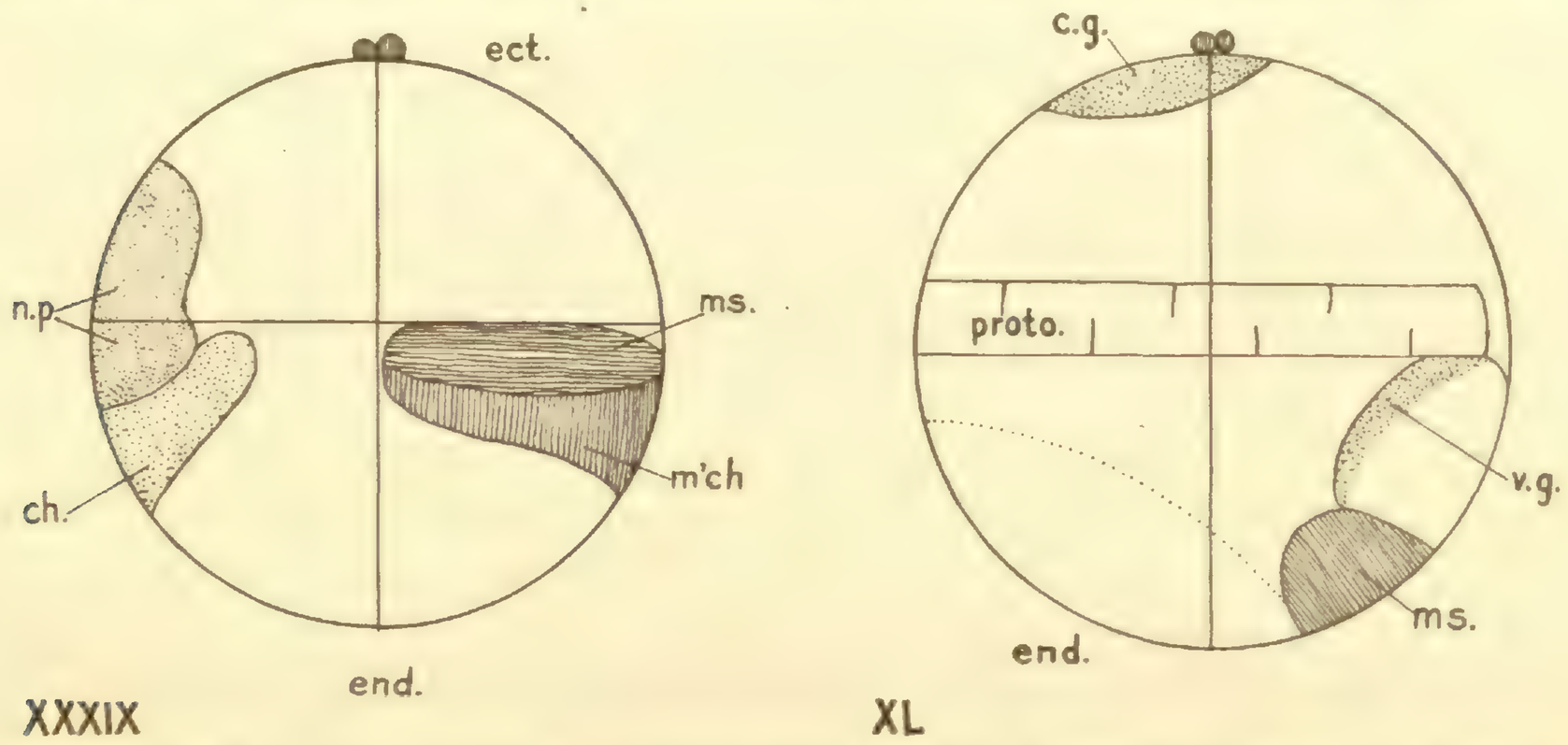
Finally, the type of localization in the ascidian egg differs in many respects from that of the other phyla mentioned, though showing certain general resemblances to all of them and particularly to the annelid-mollusk type. Castle has called attention to the fact that there are no important resemblances between ascidians and annelids in their cell-lineage, and with this opinion I entirely agree. Nevertheless, in the localization of ectoplasm, mesoplasm and endoplasm in the unsegmented egg there are many similarities between these phyla, but in the position of specific organ bases the differences are quite notable.

Among ascidians the ectoplasm which escapes from the germinal vesicle at the animal pole does not remain there, as in the fresh-water snails, but flows rapidly to the lower pole, then to the posterior side of the egg, then into the center and finally into the upper hemisphere of the egg; in other phyla the ectoplasm becomes directly localized at the upper pole, here only indirectly. The mesoplasm is first segregated at the lower pole in a manner which recalls the egg of *Strongylocentrotus*, and then finally becomes localized on the posterior side, a result which somewhat resembles the condition in annelids and mollusks; in the ascidians the cells of the mesodermal crescent lie in the posterior lip of the blastopore, in annelids and mollusks the teloblasts and mesodermal bands lie in a similar position in the early gastrula stages, but owing to the closure of the blastopore from behind forward they are ultimately removed some distance from the blastopore lip. The mesoderm and mesodermal organs may therefore be said to arise from corresponding regions of the egg in these two groups of animals (text figs. XXXIX, XL). The endoplasm also is localized in corresponding regions of the egg in these phyla.

When, however, we come to compare the positions in the eggs of these phyla of important organ bases the differences are very marked. For example, in annelids and mollusks the apical plate and cerebral ganglion are formed near the animal pole, the sub-oesophageal ganglia from the ventral plate, which is derived from the cell 2d, lying not far below the equator on the posterior-dorsal side and just above the mesodermal teloblasts (text fig. XL); subsequently in the concrescence of the posterior lip of the blastopore, the bases of the sub-oesophageal ganglia are carried to the ventral side. The nervous system of annelids and mollusks thus has a double origin, one portion arising from the region of the animal pole, the other from the posterior pole, and these two portions subsequently become connected together by commissures which surround the oesophagus. In the ascidian the entire central nervous system is formed as a continuous plate which lies along the anterior side of the egg, stretching from a point about 60° from the animal pole and

30° from the equator to a point a little below the equator (text fig. XXXIX); no portion of the nervous system comes from the region of the animal pole and none from the posterior pole. Furthermore, the mouth, which is here a new formation and has nothing to do with the blastopore, does not open through the nerve plate but lies between the anterior end of the neural plate and the animal pole.

We have here differences of a fundamental order, even in the earliest stages of development, between the vertebrate, or rather chordate, and the invertebrate; the early development throws no light upon the way in which the one may have been derived from the other. It is of course possible to conceive of a condition in which the nervous system surrounded the entire blastopore as a ring, which in the case of the annelids underwent concrescence from behind forward, thus forming the ventral plate and ganglia, but which in the chordates underwent concrescence from in front



FIGS. XXXIX, XL.—Diagramatic representations of the types of germinal localization in ascidians and annelids. Mesodermal substance is shaded by lines, neural substance by fine stipples, and chorda material by coarse stipples. Fig. XXXIX, the ascidian type; egg viewed from right side. The mesoplasm, composed of mesenchyme (m'ch) and muscle substance (ms), is represented in its final position, which it assumes before the first cleavage. The neural plate (n. p.) and chorda (ch.) substances are not distinguishable in the unsegmented egg, but are here shown in the positions in which they appear at the 2-cell stage; the chorda and mesenchyme substances should be shown as meeting on the side of the egg, thus forming a chorda-mesenchyme ring around the endoderm. The ectoplasm (ect.) and endoplasm (end.) are localized, as here represented, at the close of the first cleavage. Fig. XL, the annelid type; egg viewed from left side. The substances of the first and second somatoblasts (the former stippled along one border, the latter shaded by lines) are shown in the positions in which these cells are ultimately formed; in the unsegmented egg the lobe which contains the substances of these cells lies nearer the lower pole. The substances of the cerebral ganglion (c. g.), ventral ganglia (v. g.) and prototroch (proto.) are not distinguishable in the unsegmented egg, but are shown in the regions to which they may be traced by means of the cell lineage.

backwards. But however probable such a theory may be it finds little support in the early development of ascidians. It is true that a nerve ring has been described as surrounding the blastopore in ascidians, but I have not been able to find evidence of its existence. Furthermore, there is no evidence in the development of ascidians that there is any concrescence of the anterior lip of the blastopore; on the contrary the anterior lip grows backward over the archenteron as rapidly in the mid-line as at the sides,—a view in which practically all writers on ascidian embryology agree. Finally, the lack of an apical plate and cerebral ganglion at the animal pole in the ascidian constitutes a notable difference from the condition found in most invertebrates. In his great work on *Salpa*, Brooks (1893) has shown in masterly fashion

the weakness of the annelidan hypothesis of the origin of chordates and has adduced much evidence in favor of the view that the great metazoic stems run back to simple and minute pelagic ancestors whose common meeting place must be be found in still more recent times. The earliest differentations of the egg seem to me to favor this view.

In conclusion, then, it seems necessary to recognize several types of cytoplasmic localization. Between annelids and mollusks the similarities of localization extend to the bases of numerous parts and organs, thus confirming the view of the phylogenetic relationship of these two phyla based upon the resemblances in their cleavage stages and larvæ. Between the annelid-mollusk type of localization and the types found in the other phyla enumerated there are general agreements in the localization of the materials of the germinal layers, but few, if any, resemblances which extend to the bases of particular organs. The annelids do not approach the chordates nor the echinoderms in the earliest stages of localization any more closely than in their cleavage stages or later development. In all respects in which localizations differ in the eggs of these animals they resemble the later differences in their embryos. *In short, there is no convergence toward a common type of localization as one goes back to earlier and earlier stages in the ontogeny.*

Important results flow from this conclusion, for the doctrine that "Ontogeny is a short recapitulation of Phylogeny" assumes that there is such convergence toward a common type of structure in the early stages of development. If there be no such convergence the causes of the resemblances which exist between certain eggs, cleavage stages, embryos, larvæ and adults must be sought in some other direction. Students of the cell-lineage of annelids and mollusks have maintained that homologies of cleavage must be due to similarities in the protoplasmic structure of the cleavage cells. The same must also be said of the organization of the egg before cleavage begins. Similarities in the material substance of the egg and in the form of its localization must lie at the bottom of all later appearing similarities. And this fact, upon which all students of cell lineage have insisted, furnishes a possible explanation, as Morgan (1903) has recently pointed out, of the resemblances between the embryos of related forms.

Speculations as to the origin and evolution of types of germinal organization are likely to be more interesting than valuable in the present state of our knowledge. Wilson (1892) first suggested that the localization of the materials of embryonic parts or organs in certain cleavage cells was an illustration of the principle of "precocious segregation" first propounded by Lankester and afterward elaborated by Hyatt, in its application to palæontology, under the title of "the law of acceleration." Lillie (1895) maintained that "it is parallel precocious segregation which conditions cell homologies," and he further showed (1899) that the size and rate of division of individual cells in every case possesses prospective significance: in short, that the cleavage forms are beautifully adapted to produce a given type of adult structure. Recently Wilson (1903, 1904) has expressed the view that the earliest differentiations and localizations of the egg, even before cleavage begins, are examples of this same principle of "precocious segregation."

Although this principle is carefully stated so as not to directly affirm that the organization of the egg is the result of the organization of the adult, or that the adaptations of the early development have arisen secondarily after the adult structure was established, these ideas are nevertheless plainly implied. The early appearance of differentiations is usually explained as a "throwing back of adult characters upon the egg." The whole life cycle is viewed from the standpoint of the adult; the embryo and germ exist *for the purpose* of producing a certain end; the adult is primary, the germ secondary. But do not all such ideas put the cart before the horse? What is the evidence that any inherited modification of an adult structure can arise without an antecedent modification of the germ? We know that the adult is moulded upon the egg, that specific modifications of the germ do, in some cases, produce specific modifications of the adult, but the converse proposition is certainly not established. "Precocious segregation" represents the backward rather than the forward look; it is a teleological rather than a causal explanation.

As there can be no transmission of heritable qualities from one generation to another except through the germ cells, so there can be no evolution of adult forms except through the evolution of the germ cells. Any inherited modification of a species implies some modification of the germ cells of the species. Even "acceleration" or "precocity" must be due to a modification of the germ in its earliest stages,—a modification of some unknown sort which hastens differentiation.

It cannot be maintained that all those animals in which differentiations and localizations are present in the unsegmented egg are, for that reason, debarred from any further evolution, but if this be not true then it must follow that the type of egg organization must undergo modifications during the course of evolution, and granted this we have no need of the principle of "parallel precocious segregation" for explaining any of the homologies of the early development. If the resemblances between annelids and mollusks are not due primarily to the similarities in the adults or larvæ or cleavage stages, but to phylogenetic similarities in the organization of the unsegmented egg, we have in this initial resemblance a sufficient explanation of all later resemblances, whereas if we reverse this procedure and hold that the similarities of the adults or larvæ are the causes of the likenesses in the earlier stages we must of necessity resort to some such teleological principle as "precocious segregation" for an explanation.

In view of the fact that there are such definite types of differentiation and localization in the eggs of many animals and that the causes which lead to the evolution of animals must operate through modifications of this organization, the character and manner of such modification become problems of the first importance. If the nuclear inheritance theory is true, such modifications must in the first instance affect the chromosomes; but how and in what respect is wholly unknown. In the case of the cytoplasm it is evident that such modifications may concern the character, or quality, of the differentiations and the place and manner of their localization. Modification of any of these might be expected to produce modifications in the resulting animal.

Relatively slight modifications of this localization, however produced, may lead to profound modifications of the resulting embryo and adult. I have elsewhere (1903) shown reason for believing that the cause of inverse symmetry is to be found in the inverse organization of the egg, and that this inverse organization may possibly be produced by the maturation of the egg at opposite poles in dextral and sinistral forms. This case shows that one of the most remarkable forms of mutation with which we are acquainted may be the result of modifications in the localization of germinal substances in the unsegmented egg.

One of the great difficulties in explaining the origin, on evolutionary principles, of different phyla has been the dissimilar locations of corresponding organs or parts. These difficulties are well illustrated by the theories which attempt to derive the vertebrates from annelids, or from any other invertebrate type. Without assuming to defend any of these theories it may here be pointed out that if evolution takes place through modifications of germinal organization, it is no more difficult to explain the different location of parts than their different qualities. Changes in the relative positions of parts, which would be impossible in the adult, may be readily accomplished in the unsegmented egg, as is shown by cases of inverse symmetry. The question is here raised, whether some similar sudden alteration of germinal organization may not lie at the basis of the origin of new types.

SUMMARY.

I. Ascidian Embryology.

1. The orientation of the ascidian egg and embryo adopted by Van Beneden and Julin is correct, that of Seeliger, Samassa and Castle is wrong (pp. 26–37).

2. The cell-lineage given by Castle is correct for the early stages; from the 48-cell stage on it is wrong (pp. 56–59).

3. The egg axis corresponds very nearly with the gastrular axis; during the closure of the blastopore this axis is shifted so that it is no longer dorso-ventral as in the early stages, but is antero-ventral and postero-dorsal in direction in the larva (pp. 73, 75–77).

4. The relation of the germinal layers to the cleavage planes is very different from the account given by Van Beneden and Julin and by Castle, and is more nearly in accord with that of Seeliger, Davidoff and Samassa. All cells above the equator (3d cleavage plane) are ectodermal and neural plate cells; all below are endodermal, mesodermal and neural plate (pp. 47–48).

5. The factors of gastrulation are (a) change of shape of the cells of the animal and vegetal hemispheres, (b) overgrowth of the marginal cells (pp. 64–65). Peculiarities of the gastrula are foreshadowed in the egg at a very early stage (pp. 45, 50, 59).

6. The muscle and mesenchyme cells arise from a common base, the mesodermal crescent, which surrounds the posterior side of the egg just below the equator (pp. 19–21); ultimately these cells surround the posterior margin of the

blastopore (pp. 51–55); the most laterally situated of these cells become the large muscle cells of the tail of the tadpole, the portion of the crescent lying nearest the dorsal mid-line becomes mesenchyme (pp. 61–67). In the overgrowth of the dorsal lip of the blastopore the muscle cells become separated from the mesenchyme (pp. 69, 84–87).

7. The chorda arises at the anterior border of the blastopore from yolk-laden cells which resemble endoderm (pp. 53, 61, 62, 70–72, 83, 84).

8. The neural plate arises on the anterior side of the egg from cells of both hemispheres; it extends from the margin of the anterior lip of the blastopore to a point about one-third of the way from the equator to the animal pole (pp. 52–54, 61–63, 66–68, 70, 72, 73, 82, 83).

9. The nervous and muscular systems do not arise from a common base as claimed by Castle; there is no nerve ring around the blastopore (pp. 61, 72, 73).

10. A comparison of the early development of ascidians with that of *Amphioxus* and amphibians shows that there is fundamental agreement among them in axial relations of egg and larva, in bilaterality of cleavage, in the method of closure of the blastopore and probably in the origin and position in the embryo of the neural plate, the chorda and the mesoderm (pp. 73–87).

II. Cytological Results.

11. The maturation spindles are peculiar; they have no centrosomes nor asters; they are formed entirely within the nuclear area from nuclear linin and chromosomes; their fibres at first radiate in all directions, and finally they form a barrel-shaped spindle. The chromosomes separate without any possible influence from centrosomes or traction on the part of spindle fibres (pp. 15, 16).

12. In the first and second cleavages a small nuclear spindle like those present during maturation, lies between the two large asters, and in *Ciona* it is quite distinct from them. The separation of the daughter chromosomes takes place here as in the maturation divisions (pp. 40, 41).

13. The spermatozoon enters near the lower pole and rotates after entering the egg so that its centrosome is directed forward; the centrosome is derived from the middle piece of the spermatozoon and can be followed without interruption until it divides, at right angles to the copulation path, and gives rise to the sperm amphiaster and finally to the cleavage centrosomes (pp. 22–24). A netrum is formed in the division of all centrosomes (p. 40).

III. Organization of the Egg.

14. In the ovocyte of *Cynthia partita* there is a peripheral layer of yellow protoplasm, a central mass of gray yolk, and a large clear germinal vesicle, which is eccentric toward the animal pole. These same parts are present in the eggs of other ascidians, but are differently colored (pp. 11, 12).

15. When the wall of the germinal vesicle dissolves at the beginning of the maturation divisions a large amount of clear protoplasm, containing dissolved

oxychromatin, is liberated into the cell body. This clear protoplasm is eccentric toward the animal pole and is distinct from the yolk and peripheral layer (pp. 13, 17).

16. Immediately after the entrance of the spermatozoon the yellow and clear protoplasm flow rapidly to the lower pole, where the yellow protoplasm collects around the point of entrance; the clear protoplasm lies at a deeper level. The yellow protoplasm then spreads out until it covers the surface of the lower hemisphere. This flowing of protoplasm to the point of entrance of the sperm is comparable with what takes place in many animals, though here much more extensive and rapid than elsewhere (pp. 19–21, 77).

17. The withdrawal of protoplasm from the upper pole leaves the maturation spindles closely surrounded by yolk. The polar bodies are thus formed at the middle of a yolk-rich hemisphere, which is, however, the animal pole and not the vegetal pole as was claimed by Castle (pp. 19–21, 29, 30, 36, 37, 87–90).

18. The sperm nucleus moves from the point of entrance toward the equator in a path which is apparently predetermined. This path lies in the plane of the first cleavage and the point, just below the equator, at which the sperm nucleus stops in its upward movement, becomes the posterior pole of the embryo. The median plane and the posterior pole are probably not determined by the path of the spermatozoon, but by the structure of the egg. All the axes of the future animal are now clearly established,—antero-posterior, right-left, dorso-ventral (pp. 22, 26, 90–93).

19. As the sperm nucleus moves to the posterior pole the clear and the yellow protoplasm move with it; the latter collects into a yellow crescent with its middle at the posterior pole and its horns extending about half way around the egg just below the equator. This position it retains throughout the whole development, giving rise to the muscle and mesenchyme cells mentioned in 6 (pp. 19–21, 97, 98).

20. After the sperm and egg nuclei have met at the posterior pole they move in toward the center of the egg and the clear protoplasm goes with them; the only place where the latter remains in contact with the surface is along the upper border of the crescent. At the close of the first cleavage the nuclei and clear protoplasm move into the upper hemisphere, and thereafter, throughout development, this hemisphere contains most of the clear protoplasm and gives rise to the ectoderm (pp. 20, 21, 42, 102).

21. The yolk which before maturation was central in position is shifted toward the animal pole when the protoplasm flows down to meet the spermatozoon; when the sperm nucleus and surrounding protoplasm move to the posterior pole the yolk is moved down around the anterior side of the egg to the lower pole, and when the clear protoplasm moves into the upper hemisphere the yolk is largely collected in the lower hemisphere. This yolk rich area gives rise to the endoderm (pp. 20, 33–35, 42, 102).

22. At the close of the first cleavage the principal germ regions of the embryo are visible in their definite positions and proportions, *viz.*: the muscle-mesenchyme

crescent and the ectodermal and endodermal areas. The chorda and neural plate areas are also visibly different from surrounding areas at this stage (pp. 42, 50, 95, 97, 98, 108).

23. In many cases the cleavage planes do not follow the lines of differentiation but cut across them. Although cleavage is, under normal conditions, constant in form, it is less constant and fundamental than the type of localization, and the two are relatively independent (pp. 103, 104).

24. The chief factor of localization is protoplasmic flowing; cell division is a factor of subordinate value (pp. 102–104).

25. Experiments which demonstrate the totipotence of blastomeres or regions of the egg prove nothing with regard to the presence or absence of differentiation in those parts. Some eggs with a high degreee of differentiation have at the same time great capacity for regulation, *e.g.*, those of ascidians;[1] others with no greater differentiation have little regulative capacity, *e. g.*, ctenophores and mollusks. Therefore the potency of any part of an egg or embryo is no satisfactory measure of the degree of its differentiation (pp. 93–95).

26. The organization of the ovocyte is not the initial organization. The yellow protoplasm (mesoplasm) of the *Cynthia* egg is probably derived, at least in part, from sphere material (archoplasm) which arose from the nucleus at the last ovogonic division. The yolk (endoplasm) is formed by the activity of the "yolk matrix" (Crampton) which also is probably sphere material. The clear protoplasm (ectoplasm) is derived from the germinal vesicle at the first maturation division. Thus many important regions of the egg come, at least in part, from the nucleus, and a method is thereby suggested of harmonizing the facts of cytoplasmic localization with the nuclear inheritance theory (pp. 99–101).

27. There are several distinct types of germinal localization. The annelid-mollusk type does not approach that of chordates or echinoderms in the earliest stages of localization more closely than in the cleavage or gastrular stages. There is no convergence toward a common type in the earliest stages (p. 104–109).

28. Embryonic repetitions (recapitulations), as well as many other homologies, probably result from similarities of egg organization common to each type (p. 109).

29. "Precocious segregation" is not a satisfactory explanation of the origin of germinal organization (pp. 109, 110).

30. The evolution of animals must be accompanied by an evolution of the type of germinal organization; modifications of this organization are probably the immediate causes of evolution. Transformations which would be impossible in adults are readily brought about by modifications in the organization of the egg (*e.g.*, inverse symmetry). Perhaps profound mutations or even the origin of distinct types may be so explained (pp. 110, 111).

[1] See foot-note p. 95.

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EXPLANATION OF FIGURES.

All figures represented in the plates were drawn with the aid of the camera lucida. Plates I–V represent the living eggs of *Cynthia* (*Styela*) *partita*, and the colors used are in no sense diagrammatic but are as nearly as possible those which appear in life; plate VI–X show fixed and stained eggs of the same species; plates XI and XII, fixed and stained eggs of *Ciona intestinalis*. The figures of the living eggs of *Cynthia* (plates I–V) were drawn at the stage level under Zeiss Apochromatic Obj. 4 mm., Oc. 4, and are therefore magnified 250 diameters. With the exception of figs. 46–49 all the details shown in these drawings were observed in living eggs without reference to fixed and stained material; in the figures specified certain cell outlines were added to the drawings of the living eggs after a study of prepared material. The figures of plates VI–XII, with the exception of figs. 61–75, were drawn at the stage level under Zeiss Apochromatic Obj. 3 mm., Oc. 4; in the process of reproduction they have been reduced about one-fifth so that as they now appear they represent a magnification of about 266 diameters. Figs. 61–75, plate VI, were drawn under Zeiss Apochromatic Obj. 1.5 mm., Oc. 4, and therefore represent a magnification, after reduction, of about 535 diameters. The chorion and test cells, though present in most of the eggs drawn, have been omitted from all the figures, except those of plates I, VI and VII; the chorion, without the test cells, is shown in plates II–V.

Reference Letters.

A.—Anterior.
a.p.—Animal pole.
bp.—Blastopore.
ch.—Chorda
cn.—Chorion.
c. p.—Clear protoplasm.
Cr.—Crescent of mesodermal substance (yellow in *Cynthia*).
Cr. s.—Substance of crescent.
D.—Dorsal.
end.—Endoderm.
f. c.—Follicle cells (outside of chorion).
g. v.—Germinal vesicle.
kp.—Karyoplasm (achromatic substance from nucleus).
mb.—Thick membrane which becomes chorion.
m'ch.—Mesenchyme.
ms.—Muscle cells.
n.—Nucleus.
n. p.—Neural plate.
nl.—Nucleolus.
n. t.—Neural tube.
P.—Posterior.
p. b.—Polar body.
1 p. b.—First bolar body.
2 p. b.—Second polar body.
p. l.—Peripheral layer of protoplasm.
1 P. S.—First polar spindle.
2 P. S.—Second polar spindle.
Sn.—Spermatozoon.
t. c.—Test cells.
V.—Ventral.
v. end.—Ventral (caudal) endoderm.
v. p.—Vegetal pole.
y. h.—Yellow hemisphere of egg.
yk.—Yolk.
z.—Zwischenkörper (mid-body).
♂ n.—Sperm nncleus.
♀ n.—Egg nucleus.

Nomenclature of Cells.

A—Anterior half of egg; B—Posterior half; $\underline{AB}$—Right half; $\overline{AB}$—Left half; $\underline{A}$ and $\overline{A}$—Right and left anterior quadrants; $\underline{B}$ and $\overline{B}$—Right and left posterior quadrants. From the 8-cell stage onward the cells of the endodermal hemisphere are designated by capital letters, those of the ectodermal hemisphere by lower case. The first exponent indicates the cell generation, counting the unsegmented egg as the first; the second exponent the position of the cell relative to the animal and vegetal poles, cells which lie nearest the vegetal pole having the lowest exponent, those farthest away (nearest the animal pole) having the highest. See p. 37.

Plate I.

Figures of the Living Eggs of Cynthia partita; Maturation and Fertilization.

Fig. 1.—Unfertilized egg before the fading of the germinal vesicle, showing central mass of gray yolk, peripheral layer of yellow protoplasm, test cells and chorion.

Fig. 2.—Similar egg after the disappearance of the nuclear membrane, showing the spreading of the clear protoplasm of the germinal vesicle at the animal pole.

Fig. 3.—Another egg about five minutes after fertilization, showing the streaming of the peripheral protoplasm to the lower pole where the spermatozoon enters, thus exposing the gray yolk of the upper hemisphere; the test cells are also carried by this streaming to the lower hemisphere.

Figs. 4 and 5.—Other eggs showing successive stages in the collection of the yellow and clear protoplasm at the vegetal pole; clear protoplasm lies beneath and extends a short distance beyond the edge of the yellow cap.

Figs. 6–10.—Successive stages of the same egg drawn at intervals of about five minutes; viewed from the vegetal pole. In fig. 6 the area of yellow protoplasm is smallest, and the sperm nucleus is a small clear area near its center. Figs. 7–10 show stages in the spreading of this yellow protoplasm until it covers nearly the whole of the lower hemisphere; at the same time the sperm nucleus and aster move toward one side of the yellow cap and the yellow protoplasm begins to collect into a crescent at this side.

Fig. 11.—Side view of an egg of about the same stage as fig. 10, showing the eccentric position of the sperm nucleus and a small area of clear protoplasm at the upper pole where the polar bodies are being formed.

Fig. 12.—Polyspermic (?) egg, viewed from the vegetal pole, showing four collections of yellow protoplasm around as many sperm (?) nuclei (see p. 24).

CONKLIN Organization of Ascidian Egg

Plate II.

Living Eggs of Cynthia partita; First Cleavage.

Figs. 13 and 14.—Side views of egg, showing the formation of the crescent (cr.) from the yellow hemisphere; in all the figures the animal pole is above, the vegetal pole below. Above the yellow crescent is an area of clear protoplasm (c. p.).

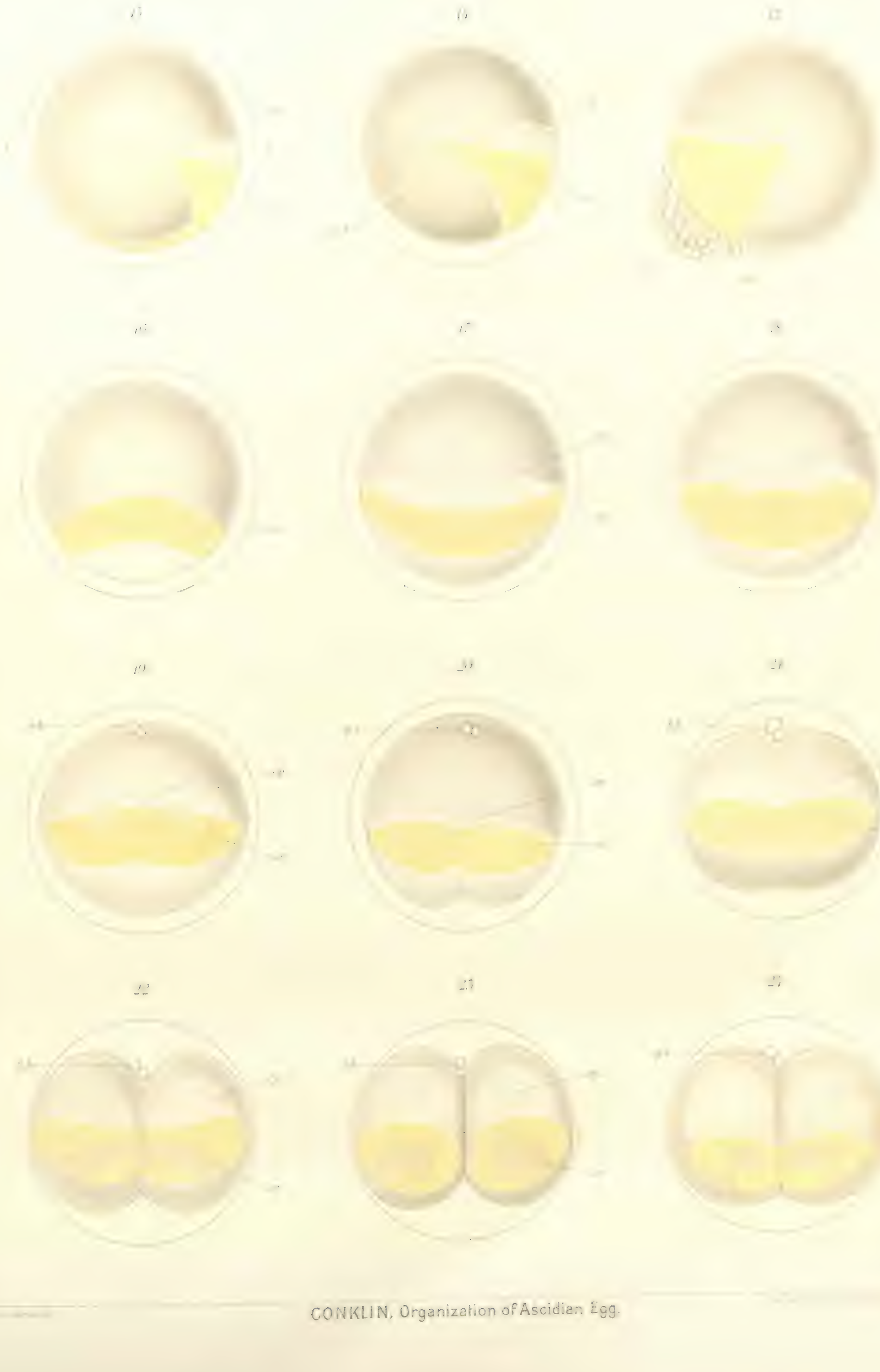
Fig. 15.—Similar stage of another egg showing the aggregation of test cells over the crescent and the protrusion of the chorion at this place,—an unusual phenomenon.

Fig. 16.—Egg showing crescent, viewed nearly from the vegetal pole.

Fig. 17.—Another egg showing crescent and clear protoplasm, viewed from posterior pole; the animal pole is above, the vegetal below.

Figs. 18, 19, 20.—Successive stages of the same egg drawn at intervals of about two minutes, showing the approaching division of the egg.

Figs. 21, 22, 23, 24.—Succesive stages in the first cleavage of an egg, drawn at intervals of about two or three minutes. The egg is viewed from the posterior pole and shows the complicated forms taken by the yellow crescent during the division, also the enlargement of the area of clear protoplasm and its extension toward the animal pole.



CONKLIN, Organization of Ascidian Egg.

Plate III.

Living Eggs of Cynthia partita; First to Fourth Cleavage.

Figs. 25 and 26.—Same egg as the one shown in figs. 21–24; final stages in the first cleavage.

Fig. 27.—Another egg at the close of the first cleavage; seen from the posterior pole.

Fig. 28.—End view of egg of same stage as preceding, showing the lateral limits of the yellow crescent, the clear protoplasm in the upper hemisphere and the yolk in the lower. The anterior portion of the lower hemisphere is composed of light gray material; this is the gray crescent and gives rise to chorda and neural plate.

Fig. 29.—Four-cell stage, viewed from the animal pole.

Fig. 30.—Similar egg seen from the vegetal pole; the crescent covers about half of the posterior blastomeres.

Fig. 31.—Eight-cell stage; the crescent is limited entirely to the two posterior blastomeres at the vegetal pole; while under observation the furrow between $\bar{B}^{4.1}$ and $\bar{b}^{4.2}$ shifted from the position indicated by the faint line to that shown by the heavy line, thus giving rise to the "cross furrow" shown in the next figure.

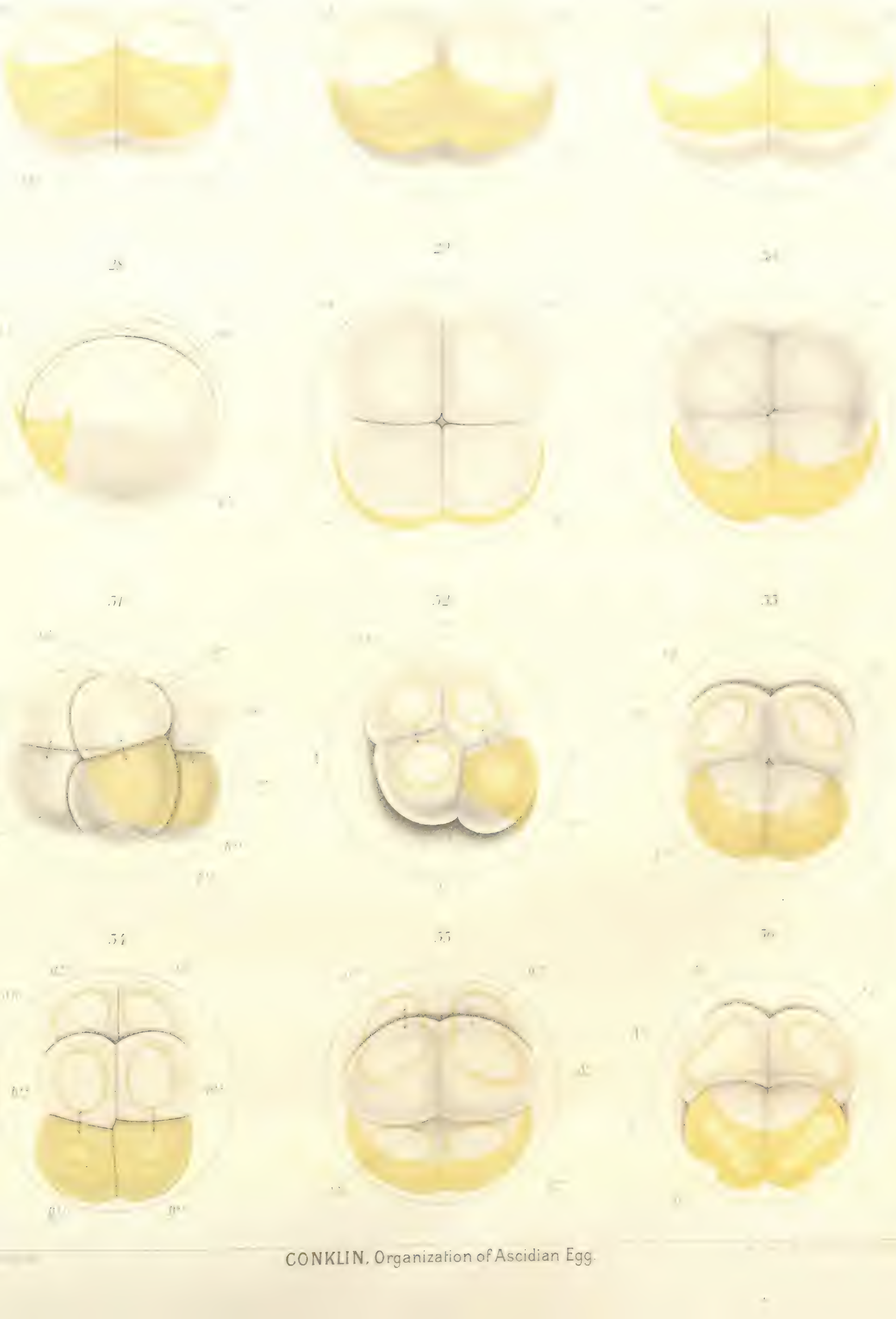
Fig. 32.—Eight-cell stage, viewed from the right side, showing a small amount of yellow protoplasm around all the nuclei.

Fig. 33.—Same stage viewed from the vegetal pole, showing the yolk laden endoderm cells and the crescent.

Fig. 34.—Same stage viewed from the posterior-animal pole, showing the clear ectodermal cells and the crescent.

Fig. 35.—Same stage seen from the anterior-vegetal pole; yellow protoplasm around all the nuclei.

Fig. 36.—Fourth cleavage of the egg seen from the vegetal pole.



CONKLIN, Organization of Ascidian Egg.

Plate IV.

Living Eggs of Cynthia partita; Fourth Cleavage to Gastrula.

Fig. 37.—Sixteen-cell stage viewed from vegetal pole.

Fig. 38.—Sixteen-cell stage, from the animal pole, yellow protoplasm around the nuclei.

Fig. 39.—Twenty-two cell stage, from the vegetal pole; four mesoderm cells (yellow), ten endoderm, chorda and neural plate cells (gray) and eight ectoderm cells (clear).

Fig. 40.—Same stage viewed from the posterior pole.

Fig. 41.—Egg passing into the 32-cell stage; postero-dorsal (vegetal pole) view.

Fig. 42.—Thirty-two-cell stage, postero-dorsal view.

Fig. 43.—Forty-four-cell stage; posterior view, showing separation of mesenchyme (m'ch) from muscle cells (ms.).

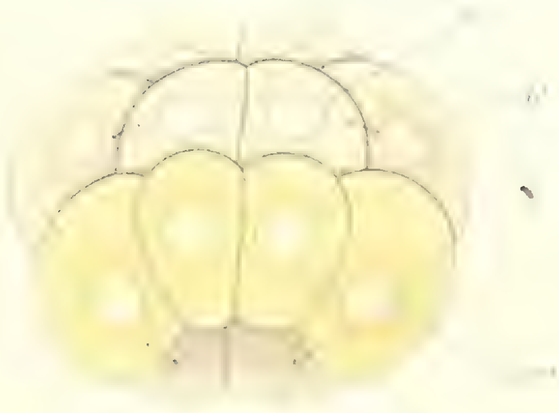
Fig. 44.—Same stage, dorsal view, showing subdivision of endoderm cells.

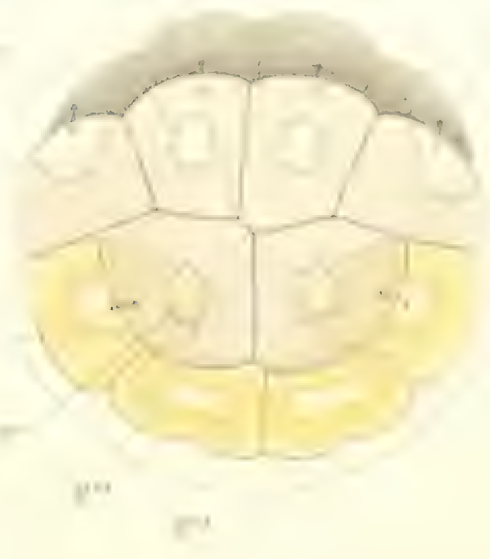
Fig. 45.—Similar stage, posterior view, showing separation of another mesenchyme cell from a muscle cell.

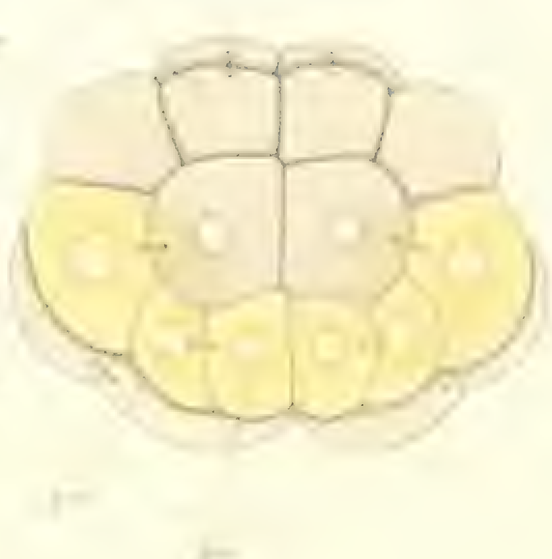
Fig. 46.—Seventy-four-cell stage, dorsal view, showing division of 4 chorda and 4 neural plate cells; there are 10 mesenchyme and 6 muscle cells, besides 10 endoderm cells.

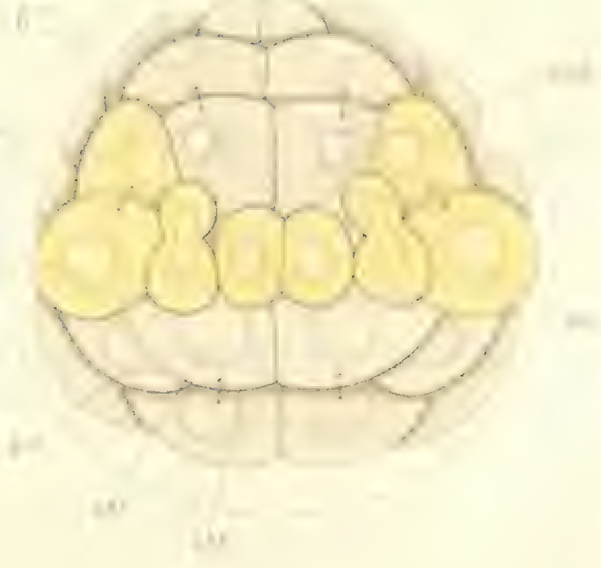
Fig. 47.—One hundred and sixteen cell-stage, showing the beginning of gastrulation, also the neural plate, chorda, muscle and mesenchyme cells.

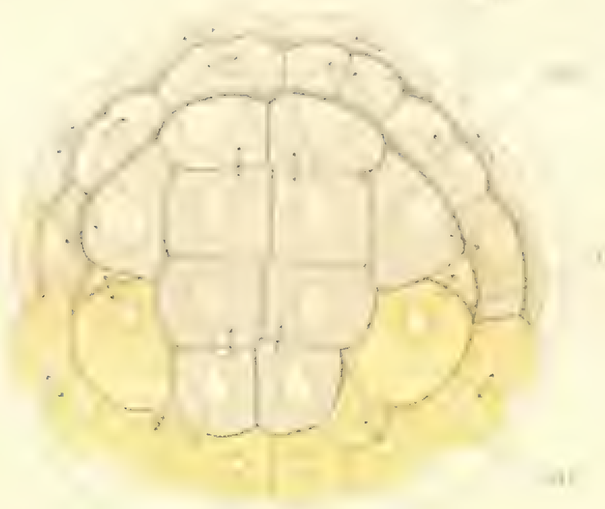
Fig. 48.—Slightly older stage showing advancing gastrulation with inrolling of cells at edge of blastopore.

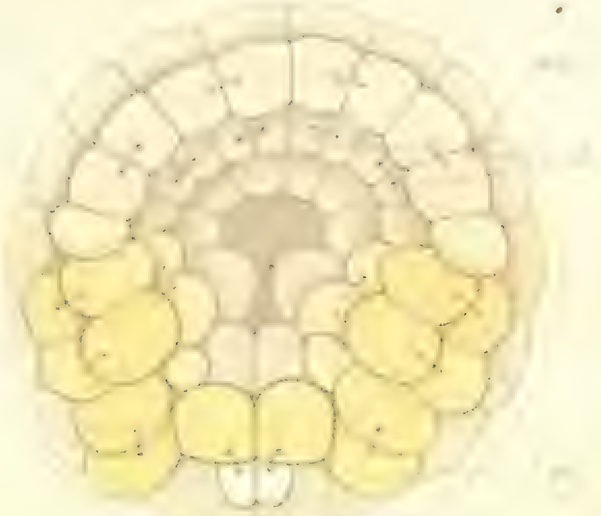












CONKLIN. Organization of Ascidian Egg.

Plate V.

Living Embryos of Cynthia partita; Gastrula to Tadpole.

Fig. 49.—Gastrula showing neural plate, chorda and muscle cells; about 176 cells,—96 ectoderm, 32 mesoderm, 20 endoderm, 8 chorda, 8 dorsal neural plate and 12 ventral neural plate cells.

Figs. 50 and 51.—Two stages of one embryo, the second drawn about ten minutes after the first; the yellow cells in the mid-line (m'ch.) are mesenchyme cells, the others (ms.) muscle cells.

Fig. 52.—Posterior view of elongated gastrula, the blastopore reduced to a narrow slit.

Fig. 53.—Dorsal view of similar stage, the blastopore a small opening at the posterior end of a groove

Fig. 54.—An older embryo, the blastopore covered by the forward growth of the posterior lips.

Fig. 55.—Embryo with inrolling neural plate and with muscle cells arranged in three rows.

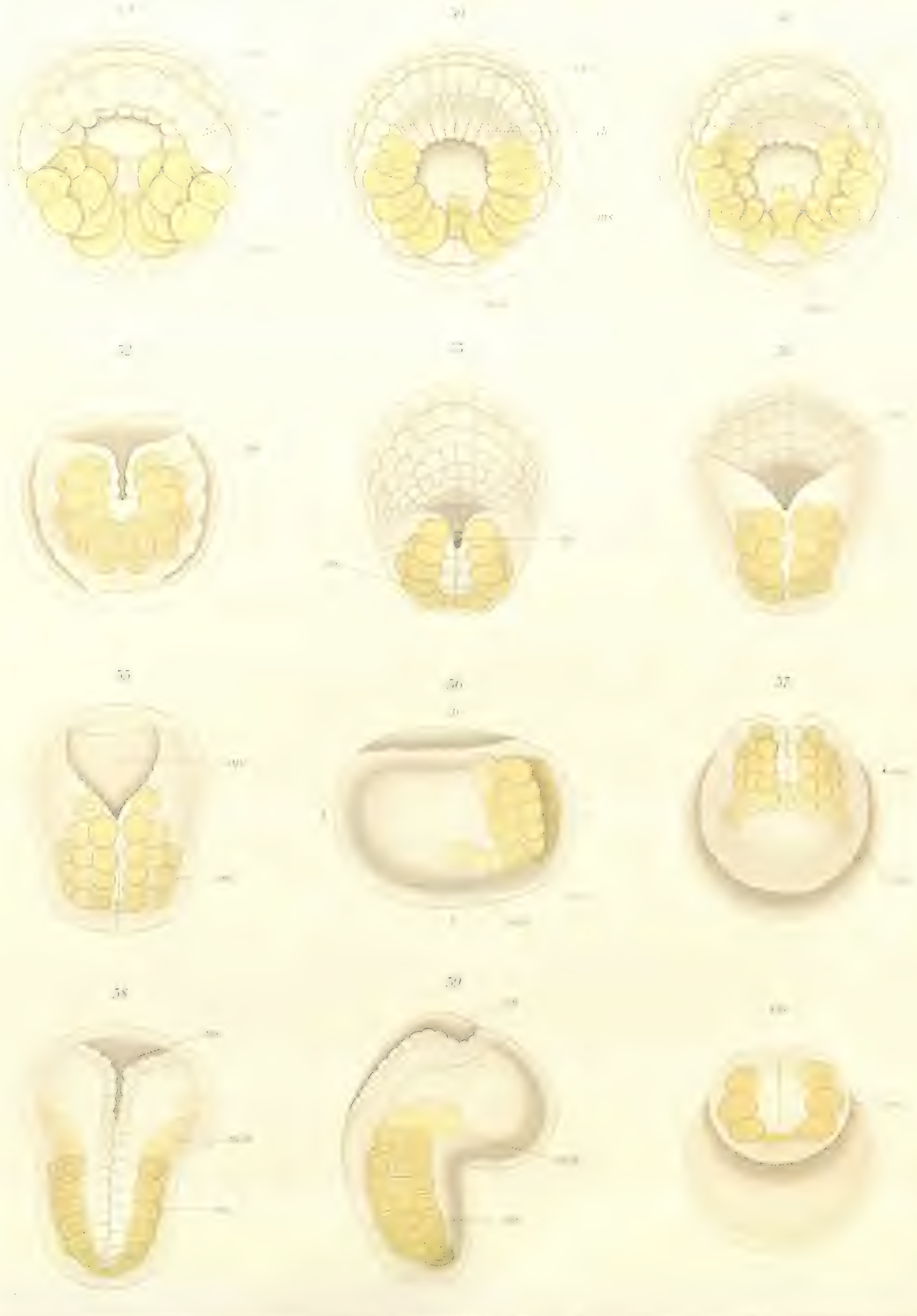
Fig. 56.—Embryo of about the same stage as that shown in figs. 52 and 53; seen from the left side showing neural groove, three rows of muscle cells which run transversely to the long axis, and a row of mesenchyme cells in the long axis.

Fig. 57.—Embryo viewed from posterior end, showing blastopore-raphe with open groove above and with three rows of muscle cells on each side, also a row of mesenchyme cells.

Fig. 58.—Young tadpole seen from dorsal side, neural groove open in front and closed behind, small-celled mesenchyme in front of large muscle cells.

Fig. 59.—Same stage as preceding seen from the right side, showing neural groove, mesenchyme and three rows of muscle cells.

Fig. 60.—Tadpole of slightly older stage viewed from the posterior (caudal) end showing on each side three large muscle cells each of which belongs to a row of such cells (*cf.* fig. 59). These muscle cells are connected across the mid-line at the posterior end by a few small mesenchyme cells.



CONKLIN. Organization of Ascidian Egg.

PLATE VI.

Sections of Eggs of Cynthia partita; Maturation and Fertilization.

Figs. 61–735 magnified 535 diameters; Figs. 76–87 magnified 266 diameters.

Fig. 61.—Ovarian egg fully formed, showing germinal vesicle surrounded by yolk, and peripheral layer of protoplasm containing test cells and yellow granules (small spheres in figure).

Fig. 62.—Free egg shortly after the dissolution of the nuclear membrane, showing in the middle of the clear karyoplasm fragments of nucleolus, chromosomes and a granular mass from which spindle fibres arise; the peripheral protoplasm contains yellow granules.

Fig. 63.—Egg similar to the preceding, but with the spindle fibres more fully formed.

Fig. 64.—Similar to preceding, spindle fibres radiate in all directions.

Fig. 65.—The first polar spindle lies near the surface of the egg and its fibres are approximately paratangential; the peripheral layer of protoplasm has streamed away from the animal pole and the karyoplasm from the germinal vesicle has spread out here in a broad disk.

Fig. 66.—Metaphase of first polar spindle which is nearly parallel with surface; no centrosomes present.

Fig. 67.—Anaphase of first polar spindle which is turning into a radial position.

Fig. 68.—Separation of first polar body.

Fig. 69.—Metaphase of second polar spindle, which is paratangential in position.

Fig. 70.—Anaphase of second polar spindle.

Fig. 71.—Second polar spindle approaching a radial position.

Fig. 72.—Separation of second polar body.

Fig. 73.—Fusion of chromosomal vesicles in egg to form egg nucleus.

Fig. 74.—Vegetal pole of egg of the stage shown in figs. 65 and 79, showing the entrance of the sperm into the egg and the collection of yellow granules around the sperm head.

Fig. 75.—Later stage in the entrance of the sperm; formation of sperm aster from the middle-piece.

Fig. 76.—Free egg before the solution of the nuclear membrane but after the extrusion of the test cells; the chromosomes at the periphery of the germinal vesicle.

Fig. 77.—Egg after being laid but before fertilization; chromosomes and granular substance which forms spindle fibres in the center of the karyoplasm. The egg remains in this condition until fertilized.

Fig. 78.—Same as preceding, save that spindle fibres are forming and karyoplasm has moved nearer to the animal pole.

Fig. 79.—Egg showing the entrance of the spermatozoon near the vegetal pole and the spreading of the karyoplasm into a thin cap at the animal pole.

Fig. 80.—Slightly more advanced stage showing development of sperm aster and collection of yellow granules at vegetal pole, spermatozoa have entered some of the test cells.

Fig. 81.—First polar spindle assuming a radial position; increase of cytoplasmic area surrounding the sperm nucleus and aster, the latter are moving across the egg axis and hence in the longest path toward the equator.

Fig. 82.—Stage slightly more advanced than the preceding; sperm nucleus, aster, clear and yellow protoplasm becoming eccentric toward the posterior side.

Fig. 83.—First polar body formed; prophase of second polar spindle.

Fig. 84.—Metaphase of second polar spindle; yellow protoplasm collecting into crescent.

Fig. 85.—Anaphase of second polar spindle, spermatozoa in some of the test cells.

Fig. 86.—Telophase of second polar spindle.

Fig. 87.—Movement of sperm nucleus and aster and of surrounding protoplasm to the posterior side of the egg; approach of the germ nuclei.

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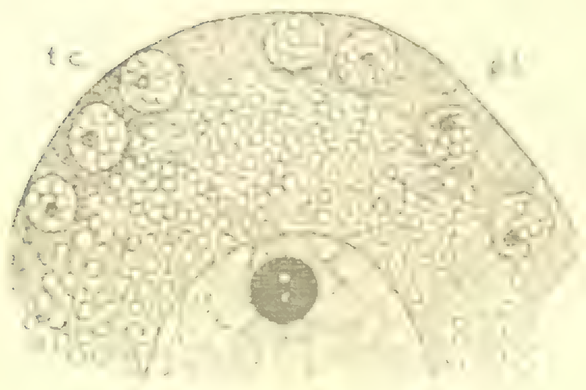

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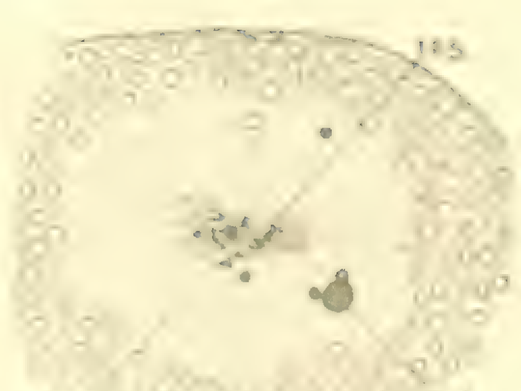

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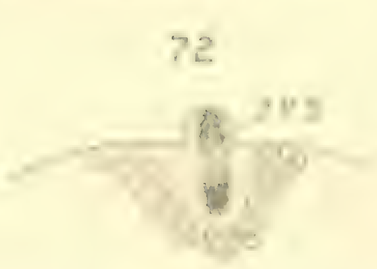

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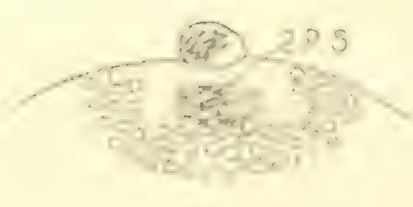

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CONKLIN, Organization of Ascidian Egg.

PLATE VII.

Sections of Eggs of Cynthia partita; Fertilization and Early Cleavages.

Fig. 88.—Division of sperm aster; crescent substance at periphery on posterior side.

Fig. 89.—Similar to preceding but showing egg nucleus.

Figs. 90 and 91.—Sections at right angles to first cleavage plane but oblique to egg axis, showing the union of pronuclei; clear and yellow protoplasm and sperm amphiaster in posterior half of egg.

Fig. 92.—Section in the plane of the first cleavage (future median plane) showing the union of the germ nuclei, the clear protoplasm and crescent on the posterior side of the egg, and the polar bodies above.

Fig. 93.—Early prophase of the first cleavage, in the plane of the spindle axis.

Fig. 94 and 95.—Two dispermic eggs; the first showing two sperm nuclei on the posterior side of the egg with a single crescent; the second, two sperm nuclei and one egg nucleus, with the clear protoplasm and crescent about equally divided, by a tongue of yolk, between the two sperm nuclei.

Fig. 96.—Section in the plane of the first cleavage and transverse to the spindle, showing a cross section of the equatorial plate near the middle of the egg, surrounded by clear protoplasm, also the crescent at the posterior border with some of the yellow spherules all around the spindle.

Fig. 97.—Metaphase of the first cleavage; equatorial section at right angles to the preceding.

Figs. 98 and 99.—Early and late anaphases of the first cleavage; sections in equatorial plane.

Fig. 99.—Constriction of cell body; chromosomal vesicles at the ends of the nuclear spindle. In both figures the daughter centrosomes are elongating in the equatorial plane and at right angles to the first spindle axis.

Fig. 100.—Telophase of the first cleavage, showing the rotation of nuclei, centrosomes and cytoplasm toward the animal pole of the egg.

Fig. 101.—Equatorial section, prophase of second cleavage; crescent substance at the posterior pole.

Fig. 102.—Section at right angles to the preceding and through the axis of one of the spindles; nucleus and cytoplasm lie above the equator, yolk and crescent below.

Fig. 103.—Equatorial section showing precocious division of the centrosomes in one of the blastomeres.

Fig. 104.—Anaphase of second cleavage; equatorial section; chromosomal vesicles at ends of nuclear spindles.

Fig. 105.—Telophase of second cleavage; equatorial section, showing the bending of the middle of the spindle toward the center of the egg, and a large amount of clear cytoplasm and of crescent substance in the posterior quadrants.

Figs. 106 and 107.—Two sections through one and the same egg in the eight-cell stage; the first through the anterior blastomeres; the second through the posterior. The cytoplasm is most abundant in the cells at the animal pole, the crescent substance in the two posterior-vegetal cells, though it is also found around all the nuclei. The polar bodies, which are shown in stippled outlines, are not in the plane of either of these sections, but in the region between them.

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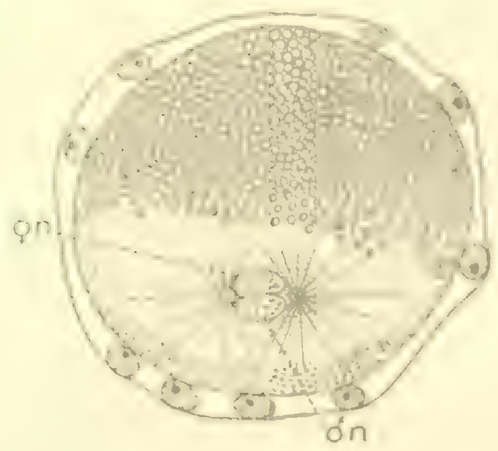

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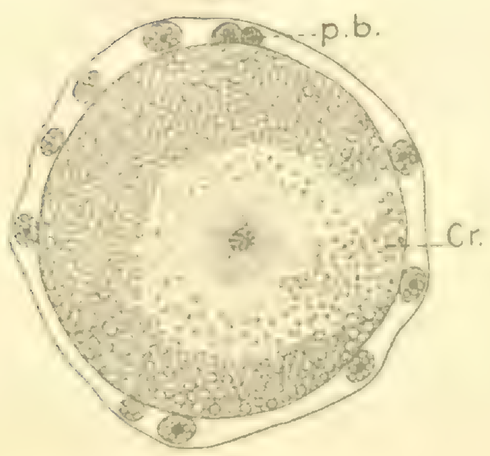

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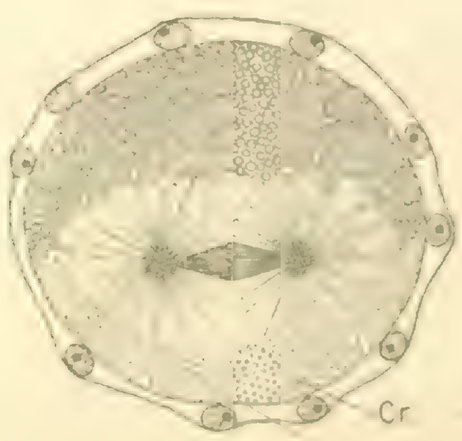

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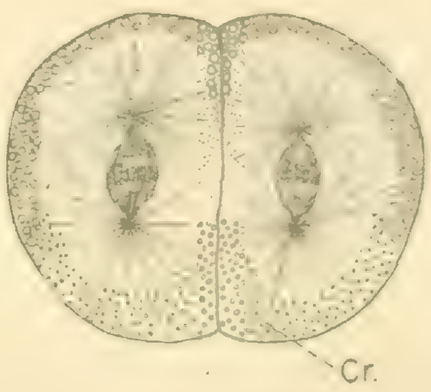

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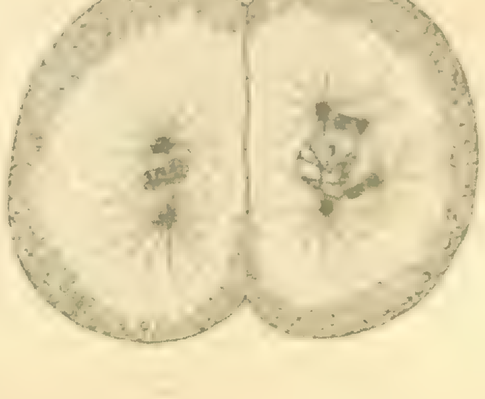

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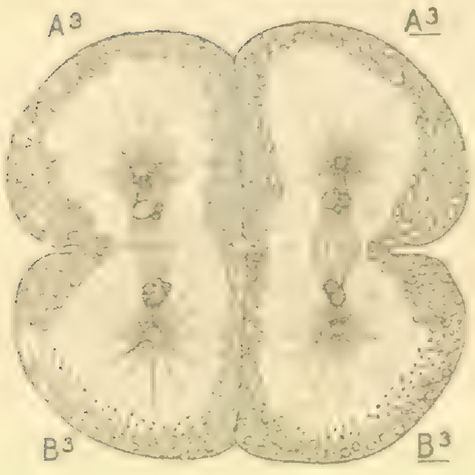

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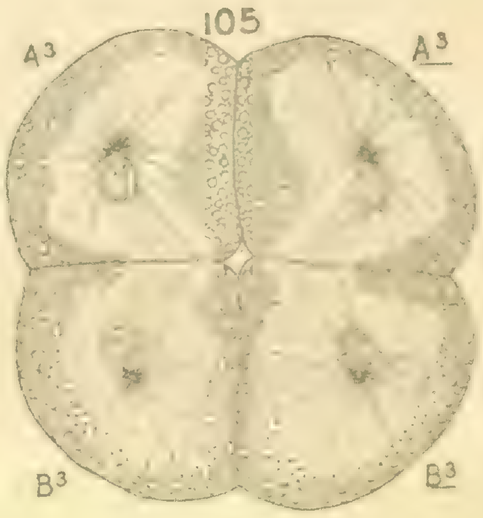

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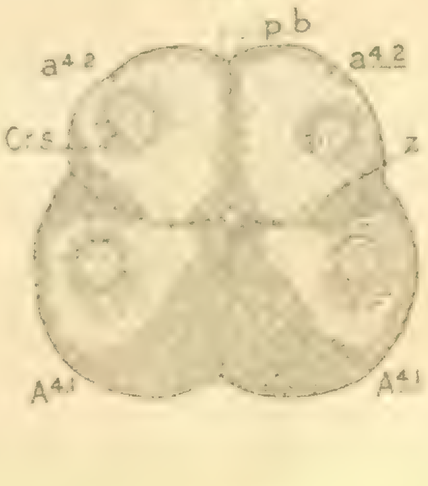

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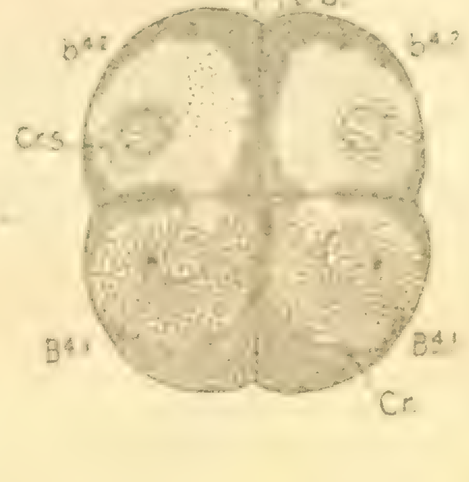

CONKLIN, Organization of Ascidian Egg.

PLATE VIII.

Surface Views of Entire Eggs of Cynthia partita; Eight to Forty-four Cells.

Fig. 108.—Eight-cell stage; left side of egg; showing spindles of third cleavage.

Fig. 109.—Anterior view of 8-cell stage, showing cytoplasm most abundant in the animal pole cells, and the yolk largely collected in the anterior cell of the vegetal hemisphere.

Figs. 110, 111, 112.—Stages in the fourth cleavage; figs. 110 and 112 viewed from the animal pole, fig. 111 from the vegetal pole.

Fig. 113.—Telophase of fourth cleavage, vegetal pole view; caps of deeply staining protoplasm lie at the hinder borders of the small posterior cells ($B^{5.2}$).

Figs. 114 and 115.—Anterior and posterior views of the 16-cell-stage; fig. 115 showing caps of deeply staining protoplasm at the posterior pole, which later go into the posterior mesenchyme cells ($B^{7.6}$, figs. 130, 131).

Figs. 116 and 117.—Ventral and dorsal views of a 20-cell stage, showing the cells at the vegetal pole dividing before those at the animal pole.

Fig. 118.—Slightly older stage with some of the animal pole cells dividing.

Figs. 119–123.—Five views of one and the same egg; fig. 119, ventral; 120, dorsal; 121, anterior; 122, posterior; 123, right side; the latter shows in dotted outlines the great elongation of the cells at the animal pole and the flattened shape of the cells at the vegetal pole; all the designations of cells in fig. 123 should be underscored; 44 cells, 16 ectoderm, 10 endoderm, 10 mesoderm, 4 chorda and 4 neural plate cells.

Figs. 124–129.—Six different views of one and the same egg in the 44-cell stage showing the divisions of the ectodermal cells and the second cells of the crescent ($B^{6.4}$); when these divisions are completed there will be 62 cells. Fig. 124, ventral; 125, dorsal; 126, anterior; 127, postero-dorsal.

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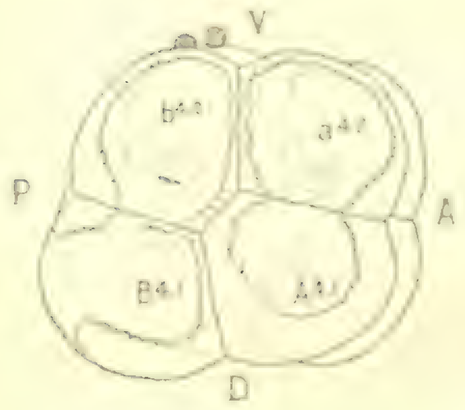

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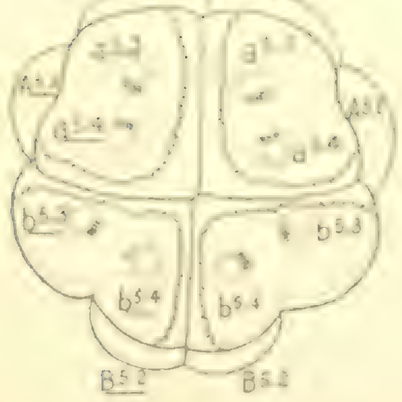

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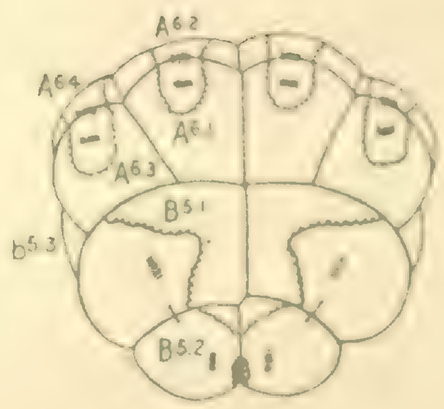

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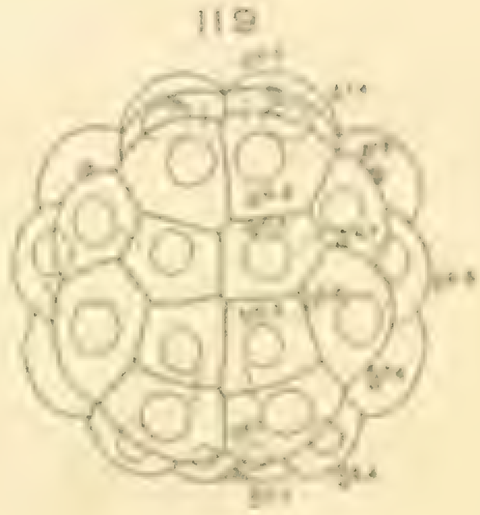

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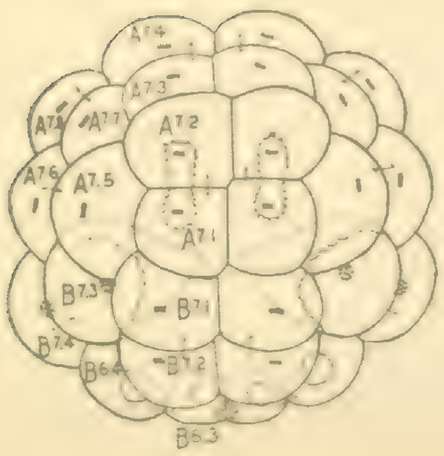

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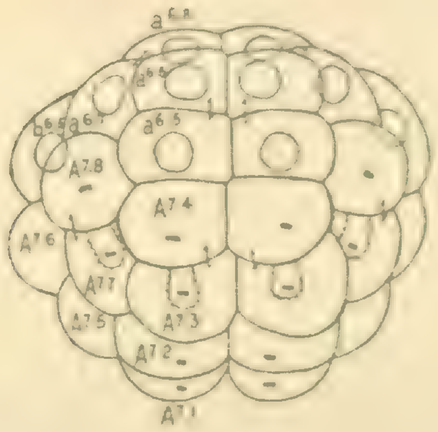

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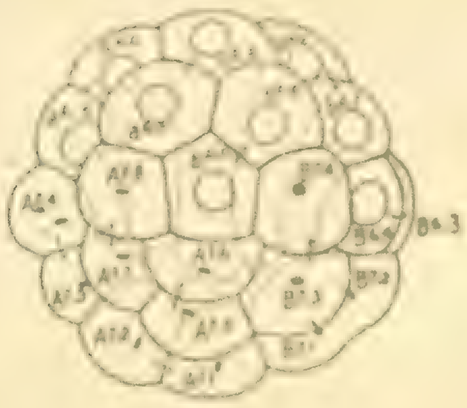

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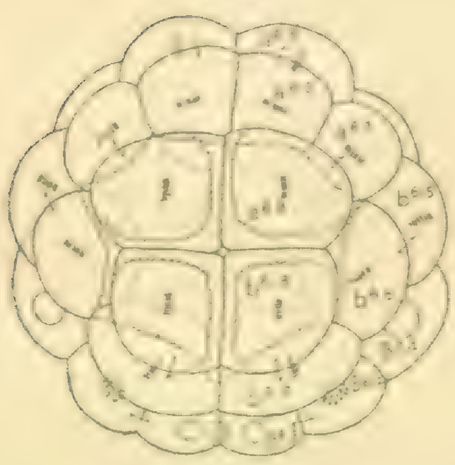

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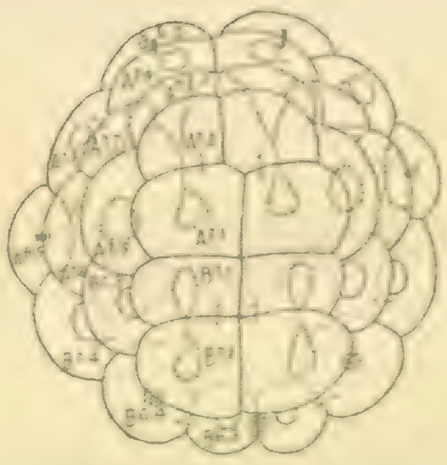

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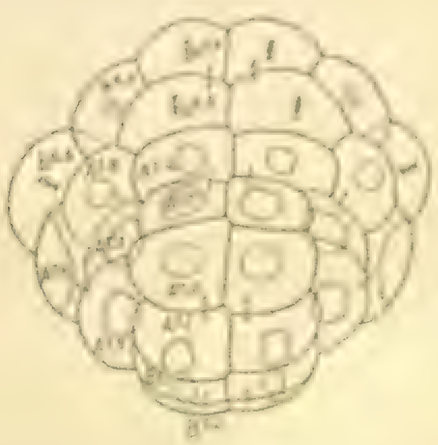

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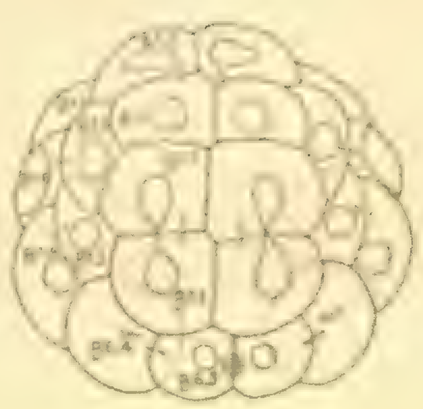

CONKLIN, Organization of Ascidian Egg

Plate IX.

Surface Views of Entire Eggs of Cynthia partita; Forty-four to Two Hundred and Eighteen Cells.

Figs. 128, 129.—Same egg as shown in figs. 124–127. Fig. 128 from the left side; the equator of the egg (plane of the third cleavage) is the heavy line running between A and P and separating cells designated by lower case from those designated by capital letters. Fig. 129.—View from the posterior pole.

Figs. 130 and 131.—Ventral and dorsal views respectively of one and the same egg; 64 cells, 32 in each hemisphere, distributed as follows: Ventral hemisphere, 26 ectoderm, 6 neural plate cells ($a^{7.10}$, $a^{7.9}$, $a^{7.13}$); Dorsal hemisphere, 10 endoderm, 4 chorda ($A^{7.3}$, $A^{7.7}$), 4 neural plate ($A^{7.4}$, $A^{7.8}$), 10 mesenchyme ($B^{7.6}$, $B^{7.5}$, $B^{7.7}$, $B^{7.3}$, $A^{7.6}$) and 4 muscle ($B^{7.8}$, $B^{7.4}$).

Fig. 132.—Postero-dorsal view of an egg in the same stage as the preceding showing direction of division of mesenchyme cell ($B^{7.3}$).

Figs. 133 and 134.—Ventral and dorsal views respectively of one and the same egg; 110 cells; Ventral hemisphere 64 cells, 52 ectoderm, 12 neural plate ($a^{8.19}$, $a^{8.20}$, $a^{8.17}$, $a^{8.18}$, $a^{8.25}$, $a^{8.26}$); Dorsal hemisphere 46 cells, 10 endoderm, 8 chorda ($A^{8.5}$, $A^{8.6}$, $A^{8.13}$, $A^{8.14}$), 8 neural plate ($A^{8.7}$, $A^{8.8}$, $A^{8.15}$, $A^{8.16}$), 12 mesenchyme ($B^{7.6}$, $B^{7.5}$, $B^{7.7}$, $B^{8.5}$, $B^{8.6}$, $A^{7.6}$), 8 muscle ($B^{8.7}$, $B^{8.8}$, $B^{8.15}$, $B^{8.16}$). Gastrulation has begun.

Fig. 135.—Dorsal view of a slightly more advanced stage showing increasing gastrulation; 118 cells, ventral hemisphere 64 cells, dorsal hemisphere 54, *viz.*, 10 endoderm, 16 mesenchyme, 12 muscle, 8 chorda, 8 neural plate; when the divisions indicated by spindles are completed there will 4 additional endoderm and 2 additional mesenchyme cells.

Figs. 136–139.—Four views of one and the same egg; fig. 136 dorsal, 137 posterior, 138 anterior, 139 ventral; gastrulation well advanced. 124 cells; Ventral hemisphere 64 cells, 52 ectoderm, 12 neural plate ($a^{8.19}$, $a^{8.20}$, $a^{8.17}$, $a^{8.18}$, $a^{8.25}$, $a^{8.26}$); Dorsal hemisphere 60 cells, 14 endoderm, 8 chorda, 8 neural plate, 18 mesenchyme, 12 muscle. Spindles are already present for divisions, which, when completed, will lead to 178 cells, *viz.*, 96 ectoderm, 12 neural plate of ventral hemisphere, 12 neural plate of dorsal hemisphere, 8 chorda, 20 mesenchyme, 12 muscle, 18 endoderm.

Figs. 140–143.—Four views of one and the same egg; 140 dorsal, 141 posterior, 142 anterior, 143 ventral. Gastrulation is here far advanced. 180 cells; Ventral hemisphere 108 cells, 96 ectoderm, 12 neural plate; Dorsal hemisphere 72 cells, 12 neural plate of dorsal hemisphere, 8 chorda, 20 mesenchyme, 12 muscle, 20 endoderm; when the divisions indicated by spindles are completed there will be 4 additional neural plate cells.

Figs. 144 and 145.—Two views of the same egg; 144 dorsal, 145 median optical section in sagittal plane. In fig. 145 the polar body is not visible, but its supposed position is indicated by the dotted outline at the animal pole; the dotted outlines at the lower pole indicate the mesoderm cells which lie in the lateral lip of the blastopore and out of the plane of the section; the rolling in of the muscle cells in the lateral lips is well shown.

Fig. 146.—Anterior view of an egg of about the same stage as the preceding, showing the division of the 12 neural plate cells of the ventral hemisphere.

Fig. 147.—Ventral view of a similar stage with the ectoderm omitted in order to show the endoderm and mesoderm from the ventral side. At this stage all the ectoderm cells have passed into the 9th generation, all the endoderm into the 8th or 9th, all the mesoderm except $B^{7.6}$ into the 8th or 9th, all the chorda and neural plate cells into the 9th. There are 218 cells; Ventral hemisphere 128 cells, 104 ectoderm, 24 neural plate of ventral hemisphere; Dorsal hemisphere 90 cells, *viz.*, 16 neural plate, 16 chorda, 20 mesenchyme, 12 muscle, 26 endoderm.

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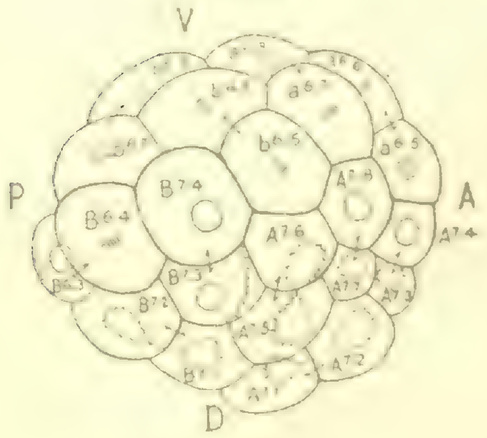

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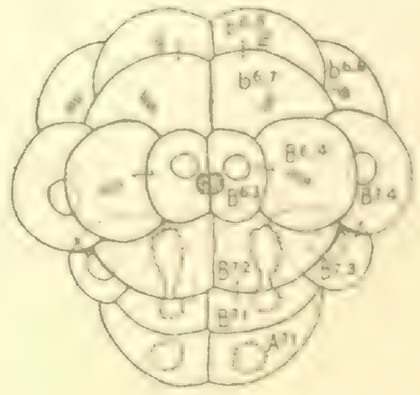

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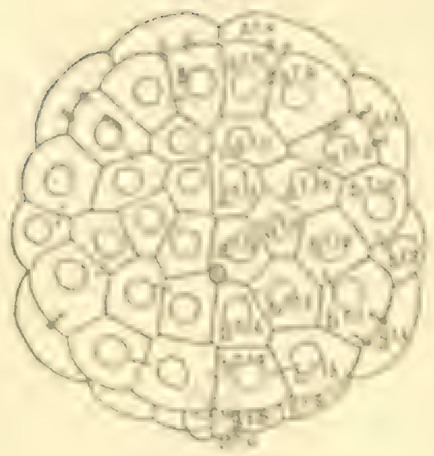

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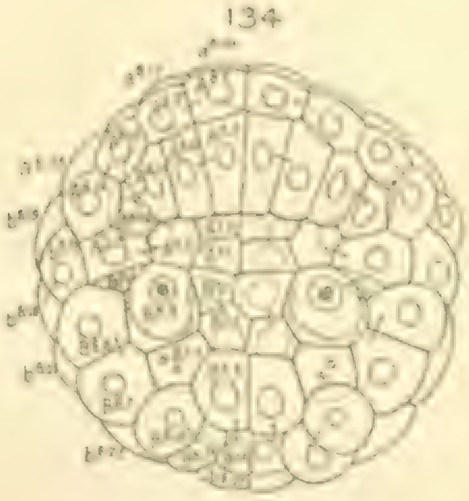

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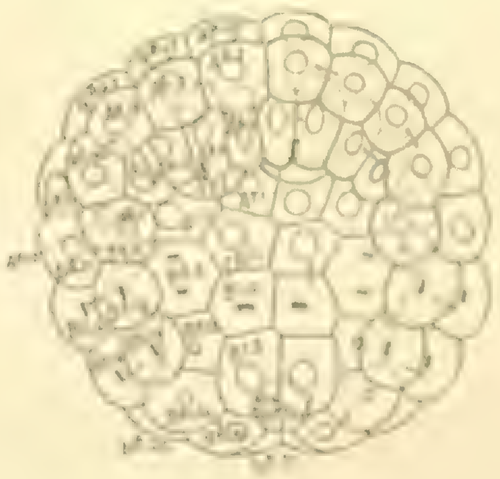

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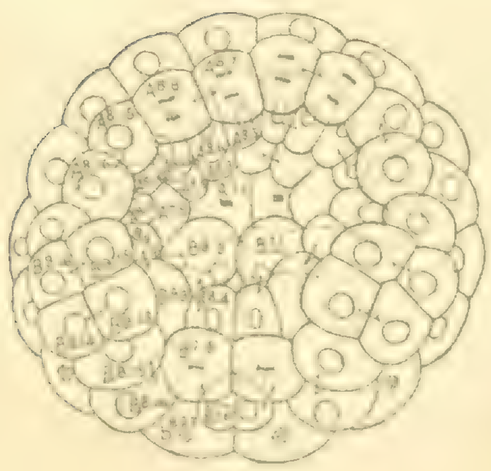

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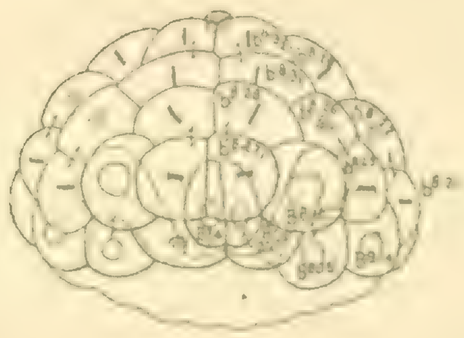

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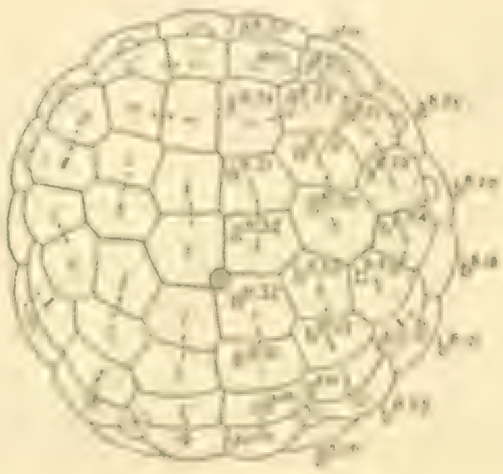

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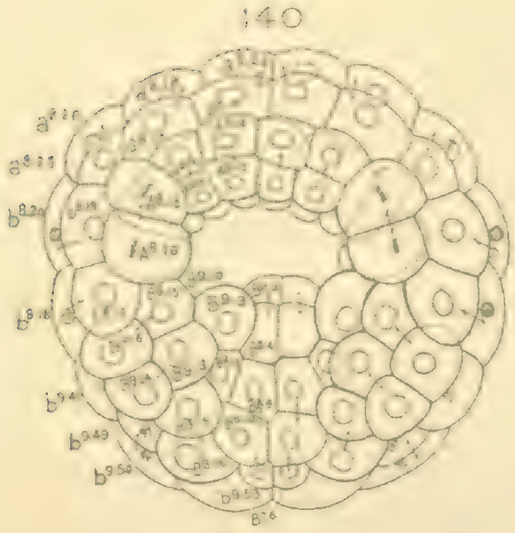

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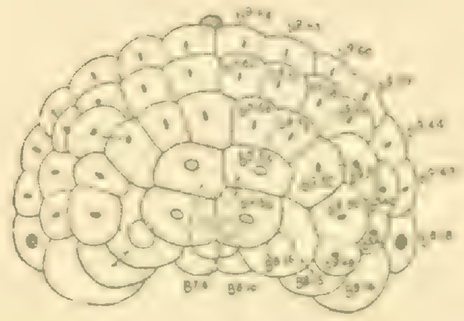

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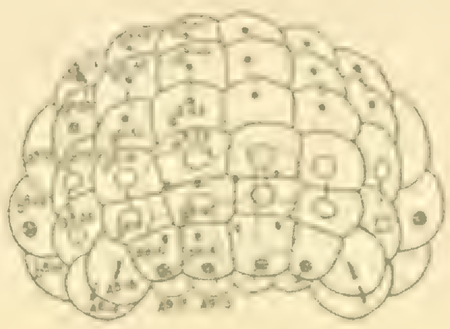

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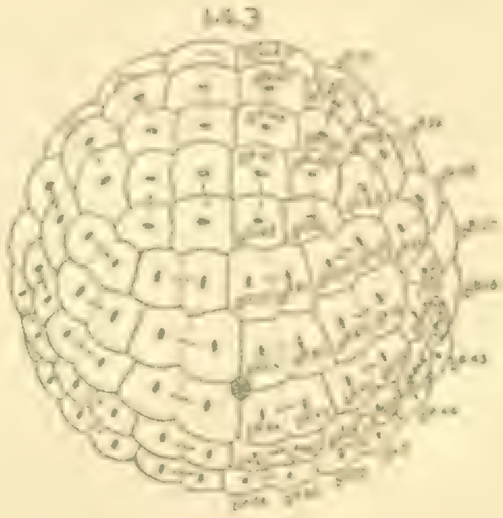

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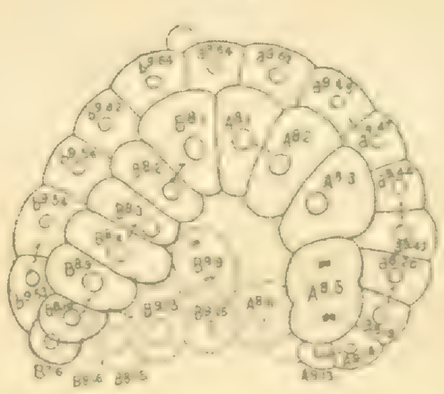

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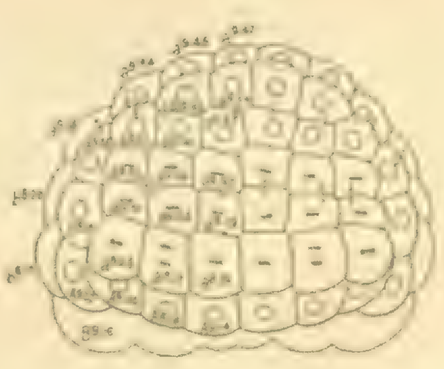

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CONKLIN, Organization of Ascidian Egg

Plate X.

Entire Embryos of Cynthia partita; Gastrula to Tadpole.

Muscle cells shaded by vertical lines, mesenchyme by transverse lines, nerve plate and tube by fine stipples, chorda by coarse stipples.

Figs. 148–151.—Four views of the same embryo; fig. 148 dorsal, 149 ventral-posterior, 150 same view but deeper level, showing mesoderm and endoderm, 151 right side. Many of the ectoderm cells are passing into the 10th generation.

Figs. 152–154.—Three views of one embryo; fig. 152 dorsal, showing closure of the blastopore from in front, 153 same view but deeper level, showing cells beneath the ectoderm, 154 ventral view of mesoderm and endoderm below ectoderm.

Figs. 155 and 156.—Two ventral views of an advanced gastrula, the first showing the superficial ectoderm, the latter the endoderm and mesoderm lying beneath the ectoderm.

Fig. 157.—Left side of embryo, showing, in optical section, muscle cells, mesenchyme, chorda and nerve plate.

Figs. 158 and 159.—Two optical sections of the same embryo, the former (158) through the open blastopore at the posterior end of the embryo, the latter (159) through the region anterior to the blastopore.

Figs. 160–162.—Three views of the same embryo from the ventral side but drawn at different levels; 160 surface view showing ectoderm; 161 same view deeper level, showing mesoderm and endoderm; 162 same view still deeper level, showing chorda, mesoderm and endoderm.

Fig. 163.—Dorsal view of embryo of same stage as preceding showing nerve plate and tube, mesoderm and chorda.

Figs. 164 and 165.—Two views of same embryo from right side; fig. 164 median optical section showing chorda, nerve tube and endoderm; 165 more superficial view showing muscle cells and mesenchyme.

Fig. 166.—Older embryo from right side, showing in optical section nerve tube, chorda, mesoderm and endoderm.

Fig. 167.—Young tadpole from left side showing in optical section nerve tube, chorda and mesoderm.

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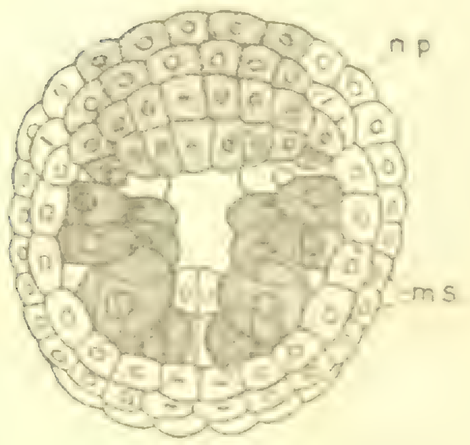

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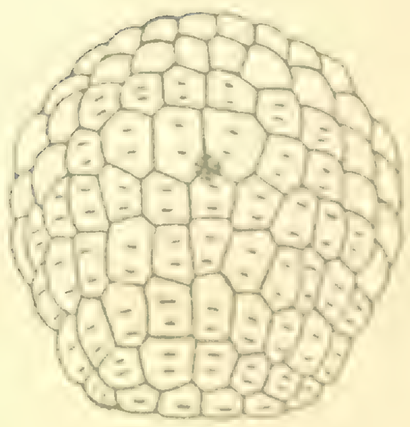

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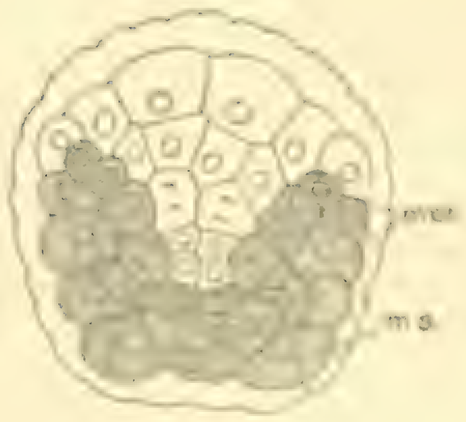

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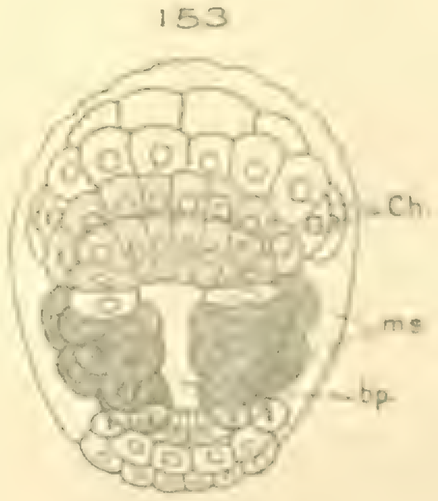

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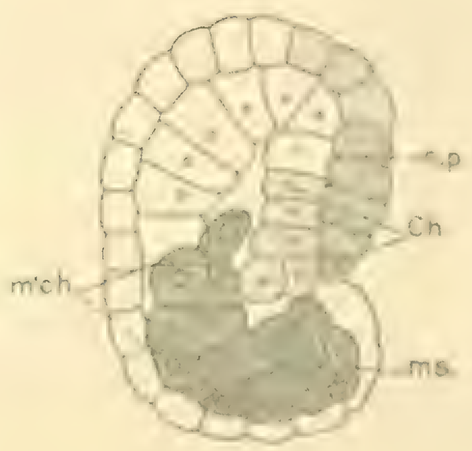

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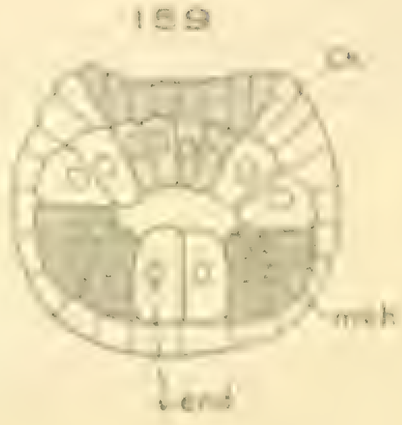

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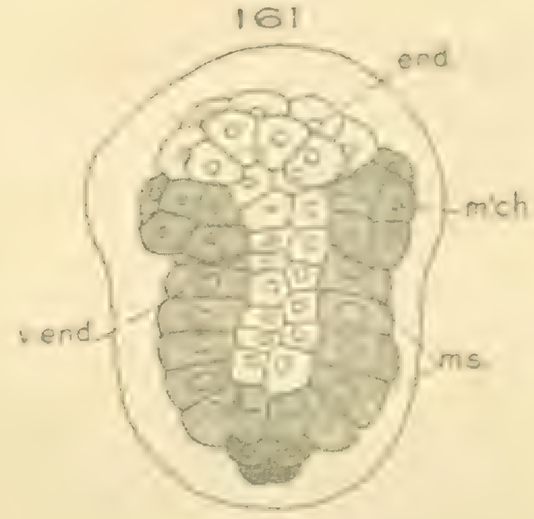

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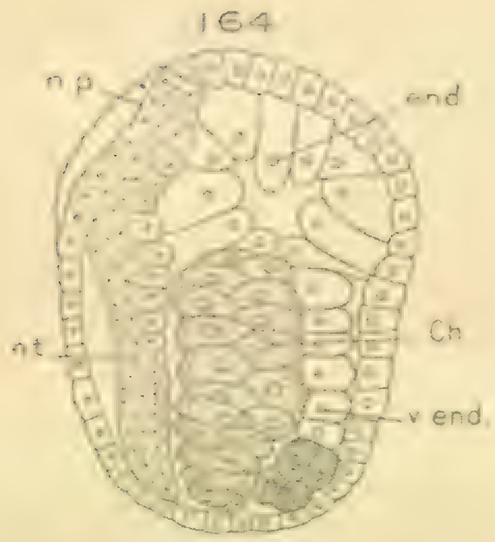

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CONKLIN, Organization of Ascidian Egg.

PLATE XI.

Eggs of Ciona intestinalis; Ovocyte to Fourth Cleavage.

Figs. 168-179 actual sections; figs. 180–187 whole eggs. Crescent substance and clear protoplasm stippled. Polar bodies are actually present where drawn.

Fig. 168.—Half grown ovarian egg, showing test cells within the egg cytoplasm, which is composed of a layer of yolk surrounding the nucleus and a peripheral layer of clear protoplasm; around the whole egg is a layer of small follicle cells which later develop into the very large conical cells which surround the chorion.

Fig. 169.—Older ovarian egg, showing the area of the yolk increased and the test cells limited to the peripheral layer of protoplasm, which is sharply differentiated from the yolk.

Fig. 170.—Still older ovarian egg, showing the test cells arranged in groups or "nests" at the periphery of the egg.

Fig. 171.—Ripe ovarian egg ready to escape from the ovary, showing the extrusion of the test cells and the formation of a thick homogeneous membrane around the egg, which ultimately becomes the chorion.

Fig. 172.—Free but unfertilized egg which has shrunken away from the chorion, showing the first maturation spindle, the peripheral layer of protoplasm collected over the lower pole of the egg and the achromatic substance of the germinal vesicle (kp) spread in a broad layer over the upper pole and around the central yolk.

Fig. 173.—Extrusion of first polar body and entrance of spermatozoon; the sperm nucleus lies in the peripheral layer surrounded by clear protoplasm in which astral rays are developing.

Fig. 174.—Nearly equatorial section of the egg showing sperm nucleus and amphiaster at the posterior side of the egg; at the surface is the granular protoplasm of the peripheral layer.

Fig. 175.—Section of egg in plane of first cleavage (median plane), showing the approach of the germ nuclei and the movement of the peripheral layer of protoplasm from the lower pole to the posterior side to form the crescent; in the darkly staining substance of the crescent is a clear triangular area which corresponds to the clear area surrounding the sperm nucleus in fig. 173.

Fig. 176.—Section of slightly older stage in plane of first cleavage, showing the union of the germ nuclei; polar body out of the plane of section.

Fig. 177.—Anaphase of first cleavage, showing the complete separateness of the nuclear and astral portions of the mitotic figure; the crescent substance shows at the ends of the spindle.

Fig. 178.—Telophase of first cleavage, showing "zwischenkörper" (z), also the bending of spindle axis and shifting of cytoplasm and nuclei toward the animal pole.

Fig. 179.—Anaphase of second cleavage, showing separateness of nuclear and astral portions of mitotic figure, also position of crescent on postero-dorsal side; polar body out of the plane of section.

Fig. 180.—Entire egg of *Ciona*, showing formation of second polar spindle, peripheral layer of protoplasm, sperm nucleus and aster.

Fig. 181.—Anaphase of first cleavage viewed from posterior pole.

Fig. 182.—Two-cell stage seen from posterior pole, cytoplasm and nuclei lie near animal pole, crescent near vegetal.

Fig. 183.—Four-cell-stage seen from vegetal pole; the crescent covers about one-half the surface of the two posterior blastomeres.

Fig. 184.—Eight cell-stage, left side, showing cap of deeply staining protoplasm at posterior pole of cells ($B^{4.1}$), which later goes into the posterior mesenchyme cells ($B^{7.6}$, fig. 200.)

Fig. 185.—Eight cells, posterior view; spindles of the fourth cleavage present.

Fig. 186.—Fourth cleavage, vegetal pole.

Fig. 187.—Fourth cleavage, animal pole; 16 cells.

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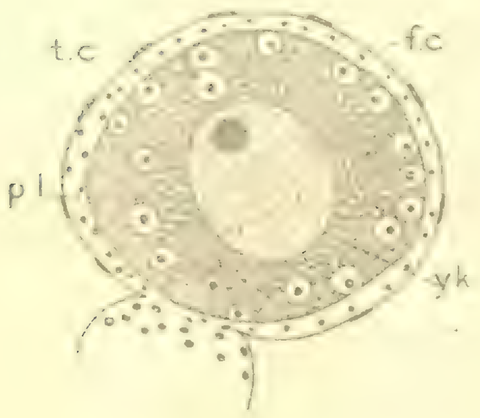

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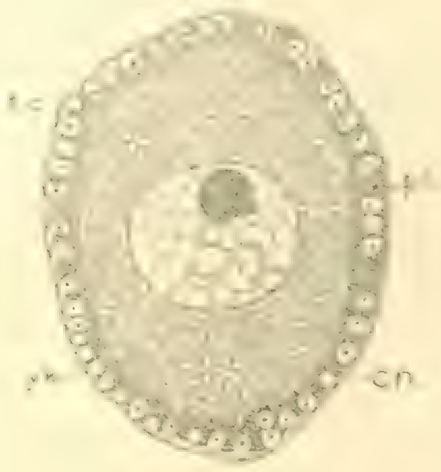

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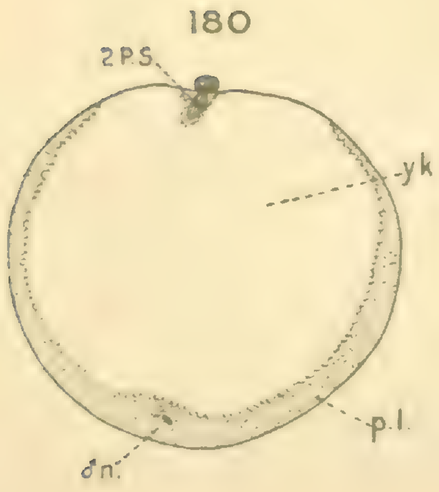

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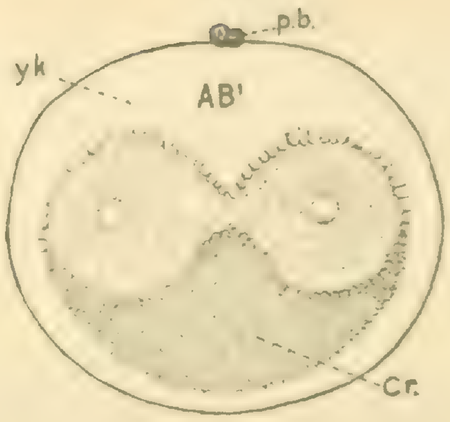

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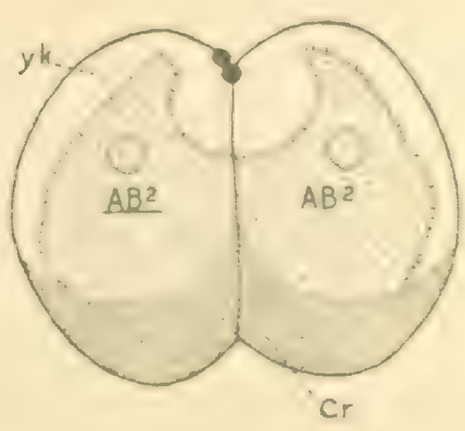

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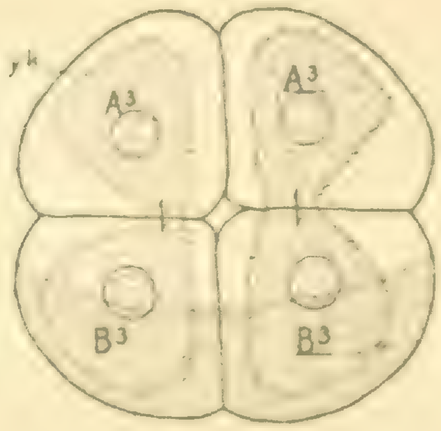

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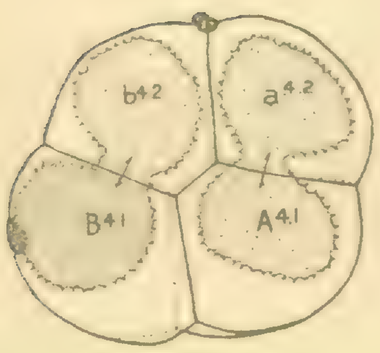

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CONKLIN, Organization of Ascidian Egg.

PLATE XII.

Whole Eggs of Ciona intestinalis; Sixteen Cells to Gastrula.

Crescent substance stippled in all the figures; clear protoplasm also stippled in figs. 188–191. Polar bodies are actually present where drawn.

Fig. 188.—Sixteen cell stage, anterior pole.

Fig. 189.—Sixteen cells seen from vegetal pole; all but two of the cells are passing from the 5th to the 6th generation.

Fig. 190.—Similar stage viewed from animal pole.

Fig. 191.—Animal pole view, 5th to the 6th generation; 20 cells; when the divisions are completed, which are here indicated by spindles, there will be 32 cells.

Figs. 192–195.—One and the same egg in the 32-cell-stage. Fig. 192.—From animal pole. Fig. 193.—From vegetal pole, spindles present in many of the cells, which are about to pass into the 7th generation. Fig. 194.—From posterior pole; all nuclei at the animal pole in a resting condition. Fig. 195.—Antero-vegetal view.

Figs. 196 and 197.—One and the same egg seen from the animal (ventral) and from the vegetal (dorsal) poles; most of the cells at the vegetal pole have just passed into the 7th generation; spindles are present in all the cells at the animal pole preparatory to their division into the 7th generation; 44 cells, 20 of the 6th and 24 of the 7th generation.

Figs. 198–204.—With the exception of fig. 199, all these figures represent views of one and the same egg. Fig. 198.—View from animal pole showing all the ectoderm cells in process of division. Fig. 199.—Another egg of the same stage as the preceding, but seen from a more anterior point of view. Fig. 200.—Vegetal pole showing all the cells at this pole in a resting condition. Fig. 201.—Same egg seen from a more anterior point of view. Fig. 202.—Same egg viewed from the anterior pole. Fig. 203.—Viewed from the right side showing in dotted outline the great elongation of the cells of the vegetal pole and a corresponding flattening of the cells at the animal pole. Fig. 204.—Viewed from the posterior pole. 76 cells, *viz.*, 32 ectoderm, 10 endoderm, 18 mesoderm, 8 chorda, 8 neural plate; when the divisions indicated in the ectoderm cells are completed there will be 64 ectoderm cells and 108 cells in all.

Fig. 205.—Gastrula corresponding in stage to fig. 140 of the *Cynthia* egg; 178 cells, *viz.*, 108 ectoderm and neural plate (ventral), 20 endoderm, 18 mesenchyme, 12 muscle, 8 chorda, 12 neural plate (dorsal).

Fig. 206 and 207.—Older gastrula with blastopore much restricted by the growth of the anterior lip. Fig. 206.—View of superficial ectoderm and mesoderm. Fig. 207.—Deeper view of same embryo showing endoderm and mesoderm.

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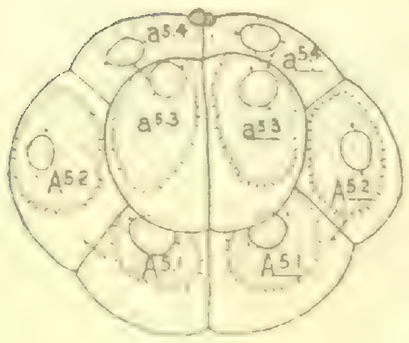

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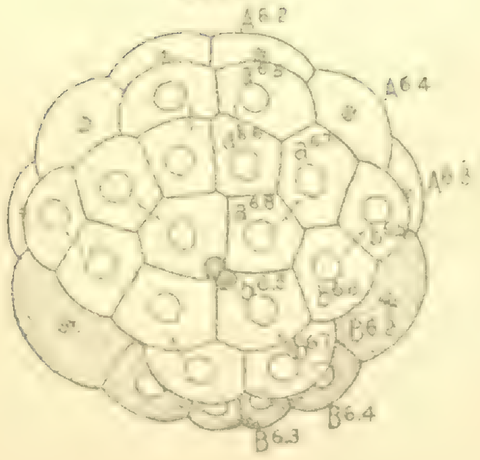

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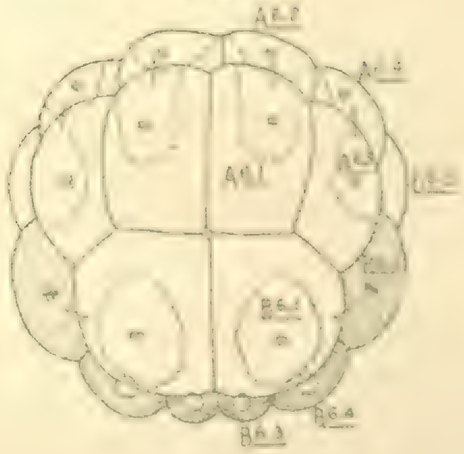

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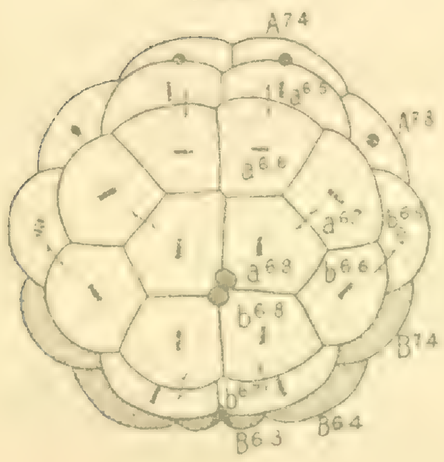

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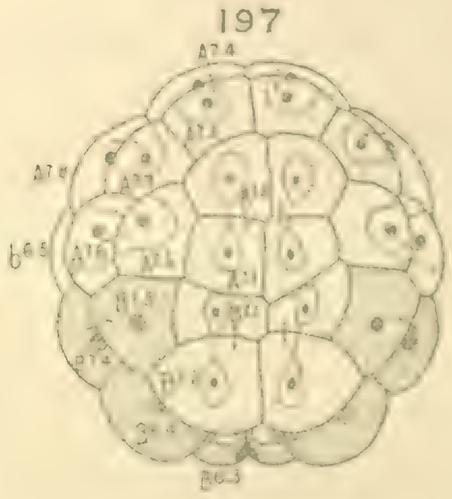

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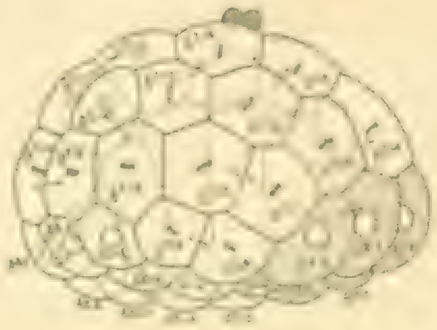

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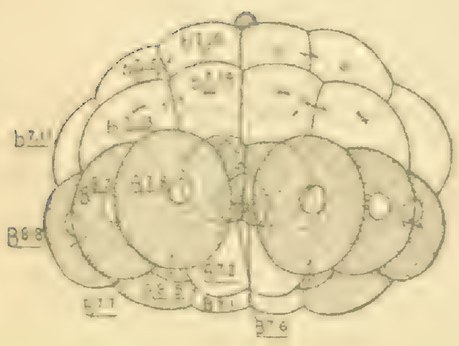

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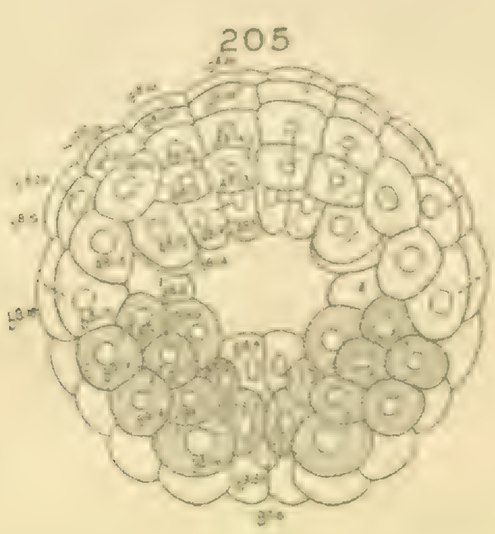

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CONKLIN, Organization of Ascidian Egg.

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March, 1905.

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*Extra copies printed for the author, March 24, 1905.

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Additional Mounds of Duval and of Clay Counties, Florida; Mound Investigation on the East Coast of Florida; Certain Florida Coast Mounds north of the St. John's River. Privately printed, Philadelphia, 1896. Quarto, 30 pages. Map, plates, illustrations in text.

Certain Aboriginal Mounds of the Georgia Coast. Journ. Acad. Nat. Sci. of Phila., 1897. Vol. XI. Quarto, 144 pages. Frontispiece, map, plates, illustrations in text.

Certain Aboriginal Mounds of the Coast of South Carolina; Certain Aboriginal Mounds of the Savannah River; Certain Aboriginal Mounds of the Altamaha River; Recent Acquisitions; A Cache of Pendent Ornaments. Journ. Acad. Nat. Sci. of Phila., 1898. Vol. XI. Quarto, 48 pages. Frontispiece, maps, illustrations in text.

Certain Aboriginal Remains of the Alabama River. Journ. Acad. Nat. Sci. of Phila., 1899. Vol. XI. Quarto, 62 pages. Map, illustrations in text.

Certain Antiquities of the Florida West-Coast. Journ. Acad. Nat. Sci. of Phila., 1900. Vol. XI. Quarto, 46 pages. Maps, illustrations in text.

Certain Aboriginal Remains of the Northwest Florida Coast, Part I; Certain Aboriginal Remains of the Tombigbee River. Journ. Acad. Nat. Sci. of Phila., 1901. Vol. XI. Quarto, 100 pages. Maps, illustrations in text.

Certain Aboriginal Remains of the Northwest Florida Coast, Part II. Journ. Acad. Nat. Sci. of Phila., 1902. Vol. XII. Quarto, 235 pages. Maps, illustrations in text.

Certain Aboriginal Mounds of the Central Florida West-Coast; Certain Aboriginal Mounds of the Apalachicola River. Journ. Acad. Nat. Sci. of Phila., 1903. Vol. XII. Quarto, 136 pages. Maps, illustrations in text.

Sheet-copper from the Mounds is not Necessarily of European Origin. American Anthropologist. Jan.–March, 1903. Plates in text.

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Aboriginal Urn-burial in the United States. American Anthropologist, Oct.–Dec., 1904. Plate.

A Form of Urn-burial on Mobile Bay. American Anthropologist, Jan.–March, 1905.

Certain Aboriginal Remains of the Black Warrior River [Moundville]; Certain Aboriginal Remains of the Lower Tombigbee River; Certain Aboriginal Remains of Mobile Bay and Mississippi Sound; Miscellaneous Investigation in Florida. Journ. Acad. Nat. Sci. of Phila., 1905. Vol. XIII. Quarto, about 200 pages. Maps, illustrations in text.

Certain Aboriginal Remains of the Black Warrior River.

Certain Aboriginal Remains of the Lower Tombigbee River.

Certain Aboriginal Remains of Mobile Bay and Mississippi Sound.

Miscellaneous Investigation in Florida.

BY

CLARENCE B. MOORE.

PHILADELPHIA
1905.

Tuscaloosa
TUSCALOOSA
Foster's Ferry
Landbridge
Hill's Gin L'd'g
Jones Ferry
R H Foster's L'd'g
Gray's L'd'g
MOUNDVILLE
Bohannon's L'd'g
Calvin's L'd'g
NEWTON
Lock No. 7
Stephen's Bluff
McAlpin's Woodyard
BEAR
Arcola
Tombigbee R.
Demopolis
MARENGO
N
MAP OF THE BLACK WARRIOR RIVER
TO TUSCALOOSA
Scale in miles
0
5
10
1905
X = mound

CERTAIN ABORIGINAL REMAINS OF THE BLACK WARRIOR RIVER.

By Clarence B. Moore.

The Black Warrior river,[1] having its sources in northern Alabama, pursues a southerly course, and passing the city of Tuscaloosa and the town of Moundville, enters the Tombigbee river just above Demopolis.

The Black Warrior river, with the aid of dams and locks, is navigable at the present time, the spring of 1905, from its union with the Tombigbee to a point a short distance above Tuscaloosa,[2] 139 miles, by water. It is with this portion of the river, our course being northward, that the present report of our work during part of the season of 1905 has to do.

Mr. J. S. Raybon, captain of the flat-bottomed steamer from which our archæological work is done, previously had spent considerable time on the river, from Tuscaloosa down, with a companion, in a small boat, stopping at each landing to make careful inquiries as to the location of cemeteries and mounds. The names and addresses of owners of these were furnished us, and, permission to dig having been obtained, there was little to do upon our arrival on the river but to proceed with the digging.

The warm thanks of the Academy of Natural Sciences of Philadelphia are tendered all owners of mounds or cemeteries, who so kindly placed their property at its disposal.

Mounds and Cemeteries.

Mound near Arcola, Hale County.
Mounds near Candy's Landing, Hale County.
Mounds near McAlpin's Woodyard, Greene County.
Mound near Stephen's Bluff, Greene County.
Mound below Lock Number 7, Hale County.
Mound at Calvin's Landing, Greene County.
Mound near Bohannon's Landing, Hale County.
Mound near Gray's Landing, Tuscaloosa County.
Mounds and cemeteries in Tuscaloosa and Hale Counties, near Moundville, Hale County.
Mound in Moundville, Hale County.
Mound near McCowin's Bluff, Tuscaloosa County.

[1] It is said on the authority of the United States Engineer Office, Tuscaloosa, Alabama, that the old name of the river from Demopolis to Tuscaloosa was Warrior, and above Tuscaloosa, Black Warrior; but that the entire river is known now as the Black Warrior.

[2] Additional locks, soon to be completed, will permit navigation a considerable distance farther up the river.

Mound and cemetery near R. H. Foster Landing, Tuscaloosa County.
Mound near Jones' Ferry Landing, Tuscaloosa County.
Mound near Hill's Gin Landing, Tuscaloosa County.
Mound and cemetery below Foster's Ferry Landbridge, Tuscaloosa County.
Cemetery above Foster's Ferry Landbridge, Tuscaloosa County.

Mound near Arcola, Hale County.

In a cultivated field bordering the water, on property of Mr. B. G. Gibbs, of Demopolis, Alabama, is a mound about one-quarter mile in a southerly direction from the landing. The mound, which apparently had long been under cultivation, was a trifle more than 7 feet in height. Its basal diameter, N. and S., was 200 feet; E. and W., 160 feet. In corresponding directions the diameters of the summit plateau were 130 feet and 90 feet. An excavation previously made in the central part of the mound showed it to be of clay at that point.

We shall say here, reverting to the subject more fully later in the report, that southern mounds of the class of which this one is, have been found to be domiciliary and not to contain burials as a rule. Sometimes, however, the flat plateaus of such mounds were used as cemeteries, which may be detected by comparatively superficial digging. This mound, dug into in many places by us, yielded no indication of burials.

Mounds near Candy's Landing, Hale County.

These two small mounds are 1.5 miles SSE. from the landing, near the northern side of Big Prairie creek. They were located by our agent, but as we were unable to obtain permission to investigate them, they were not visited by us.

Mounds near McAlpin's woodyard, Greene County.

These mounds, all in the swamp, required the services of a guide to locate them. All evidently were domiciliary and all were dug into superficially by us, without material result. They are composed of sand and clay, in varying proportions.

One of these mounds, about one-half mile in an easterly direction from the landing, is approximately 6 feet in height. The basal diameters are 55 feet E. and W., and 44 feet N. and S. The diameters of the summit plateau in the corresponding directions are 33 feet and 23 feet.

About one-quarter mile in a SSW. direction from the other is a mound 4 feet 9 inches high. The basal diameters are 62 feet and 50 feet; those of the summit plateau, 25 feet and 17 feet. This mound is of irregular outline through wash of floods.

About one-quarter mile NE. from the landing is the third mound, very symmetrical and almost exactly square. Its height is 6 feet; its basal diameter, 80 feet; the diameter of its summit plateau, 45 feet. Its sides almost correspond with the cardinal points of the compass. To the east is a great excavation with steep sides, whence came the material for its making.

Mound near Stephen's Bluff, Greene County.

This mound, at the landing, oblong and very symmetrical, with steep sides, and summit plateau as level as a floor, is on property belonging to Dr. J. W. Clements of Bartow, Polk County, Florida. Its height is 9 feet 9 inches. Its diameters are: at base, NNE. and SSW., 150 feet; ESE. and WNW., 195 feet; summit plateau in corresponding directions, 100 feet and 135 feet. The mound was dug into superficially by us in many places, in a vain search for human remains or artifacts.

Mound below Lock Number 7, Hale County.

Within sight from the water, on the eastern bank of the river, about three-quarters of a mile below lock and dam Number 7, on property belonging to the Black Warrior Lumber Co., of Demopolis, Alabama, is a mound of somewhat irregular outline, 5 feet 6 inches high, 48 feet and 40 feet in basal diameters. The mound was dug into by us without success.

Mound at Calvin's Landing, Greene County.

Within sight from the landing, almost at the edge of the bank, on property of Mr. W. B. Inge, of Greensboro, Alabama, is a square mound of clay, 4.5 feet in height, having a basal diameter of 40 feet. No measurement was taken of the summit plateau, which seemed to have been enlarged for the foundation of a house that had been upon it. No burial or artifact was met with, though considerable digging was done by us.

Mound near Bohannon's Landing, Hale County.

Following a road from the landing, through the swamp about three-fourths of a mile in an ESE. direction, one reaches a clearing on property of Mr. C. D. Cummings, Stewart Station, Alabama, in high swamp, where is a deserted house, and, nearby, the mound with a small building upon it. This mound, the sides of which almost correspond with the cardinal points of the compass, is 13.5 feet in height. Neighboring trees show a deposit of mud left by freshets, almost 8 feet from the ground; hence this mound must have afforded a welcome refuge to the aborigines in flood-time. The western end of the mound is raised about 2.5 feet higher than the rest of the mound. The maximum diameter of the mound, E. and W., is as follows: 25 feet under each slope; the lower part of the summit plateau, 34 feet; beneath slope leading to higher part of summit plateau, 18 feet; higher part of summit plateau, 27 feet; total 129 feet. The maximum diameter N. and S. is 115 feet, 65 feet of which belong to the summit plateau. Considerable digging to a depth of from 4 to 5 feet yielded in one place fragments of a human skull.

Mound near Gray's Landing, Tuscaloosa County.

In a cultivated field, on property of Mr. James W. Strudwick, of Tuscaloosa, Alabama, near the landing, was a mound which had been so much ploughed over that a mere rise in the ground remained. Considerable digging failed to show that it had been used for burial purposes.

Mounds and Cemeteries, in Tuscaloosa and Hale Counties, near Moundville, Hale County.

This famous group of mounds, near Moundville,[1] lies between the town and the Black Warrior river which is about one mile distant from the town. The larger, better preserved, and more important mounds belonging to this group are in Tuscaloosa county, on property of Mr. Hardy Clements, of Tuscaloosa, Alabama. Other interesting mounds completing the group, belonging to Mr. C. S. Prince, of Moundville, are in Hale county, the county line dividing the Clements and Prince estates. The cordial thanks of the Academy are tendered Messrs. Clements and Prince for full permission to dig, both in the mounds and in the level country surrounding them, a permission which, coming as it did in the planting season when our presence was an inconvenience, is especially appreciated.

So far as we can learn, no report of investigation at Moundville has been published, though an occasional reference, not always entirely correct, has appeared in archæological publications.

We here give a survey of these mounds, prepared at the time of our visit to Moundville by Dr. M. G. Miller, who, in addition, as in all our former archæological field studies, had charge of the anatomical work of the expedition.

The heights of the various mounds, which depend on the side whence the altitude was taken, are as follows:

Mound A.—21 feet 10 inches.
Mound B.—57 feet.
Mound C.—From 18 feet 9 inches to 20 feet 6 inches.
Mound D.—16 feet 6 inches.
Mound E.—From 15 feet 7 inches to 19 feet 6 inches.
Mound F.—From 15 feet 9 inches to 21 feet 2 inches.
Mound G.—From 20 feet 9 inches to 22 feet 6 inches.
Mound H.—From 9 feet 6 inches to 10 feet 4 inches.
Mound I.—13 feet.
Mound J.—From 13 feet 10 inches to 16 feet.
Mound K.—From 13 feet 9 inches to 14 feet 2 inches.
Mound L.—From 12 feet 9 inches to 14 feet 10 inches.
Mound M.—From 11 feet 7 inches to 12 feet 9 inches.
Mound N.—From 18 feet 11 inches to 21 feet 2 inches.
Mound O.—From 16 feet 9 inches to 21 feet 7 inches.
Mound P.—From 23 feet 6 inches to 26 feet 10 inches.
Mound Q.—From 11 feet 5 inches to 17 feet.
Mound R.—20 feet 10.5 inches.
Mound S.—3 feet.
Mound T.—6 feet 5 inches.

This great group of mounds, all above the highest level attained by the river,

[1] The town, until recently, was called Carthage, and is thus spoken of in various publications.

MOUNDS NEAR MOUNDVILLE, ALA.

Scale in feet

0 50 100 500

1905

so that no need for refuge from flood impelled their building, lies on a level plain extending back from the river bluff. This plain could have afforded ample space at all stages of the river for the games and ceremonies of an aboriginal center, which at one time Moundville must have been. Evidence of aboriginal occupancy extends in all directions beyond the limits of the circle.

The mounds, which have been approximately oblong or square in outline, with summit plateaus usually level, are so arranged that two principal ones are surrounded by the rest. One of these, Mound A in the survey, fairly central, exceeds in area any of the others, the basal diameters being 195 feet and 351 feet; while Mound B surpasses the others in altitude, its height being 57 feet.

Near many of the mounds are depressions, formed by excavating the material for their building, some containing water, others drained by means of ditches. These depressions are not present within what, for convenience, we call the circle formed by the mounds (although it is not exactly circular), but are sometimes to one side of the mounds, sometimes outside the circle; and the mounds within the enclosed space do not have such depressions. It is evident, then, that the mounds were built according to some fixed plan, and that these shallow ponds were intentionally placed outside the area of the circle, perhaps that those living on the plain within could have more convenient access to the mounds.

Certain of the mounds have graded ways, more or less distinct, leading to their summits. These ways are shown on the survey. Others of the mounds may have had similar ways; but if so they have become effaced through cultivation or wash of rain, or both.

At the northern side of Mound B is an artificial plateau, marked V on the survey, one and two-thirds acres in extent, roughly speaking. This plateau ranges in height from 2 feet 6 inches to 16 feet 5 inches, the greatest altitude being at the northeastern part.

On the survey are shown deep gullies formed by wash of rain which seems gradually to be eating away the territory on which the mounds are situated.

The ridge north of Mound R, particularly described in the report, is marked U on the survey; and W is the field north of Mound D, where much digging was done.

Excavations made previous to our visit to Moundville are shown on the plans of the various mounds.

Although we were provided with efficient apparatus in abundance to take photographs, and there were those on our steamer amply able to do so, no photographic illustrations of the Moundville mounds will be given in this report. Long experience has shown us that a photograph of a mound, through undue exaggeration of the foreground, is worse than valueless; it is misleading. A mound, stupendous to the human eye, appears quite ordinary in size in a photograph.

Although there had been considerable digging into the smaller mounds of Moundville previous to our visit, no record has been kept of the result, and the artifacts, if any were found, are not available.

On the other hand, one continually hears of interesting "finds" made in the level ground in the vicinity of the mounds, and the history of the objects discovered can be traced.

We are indebted to Mr. C. S. Prince, of whom we have spoken as one of the present owners of the Moundville mounds, for exact details of the discovery there of effigy-pipes of stone, many years ago.

Mr. O. T. Prince, father of Mr. C. S. Prince, acquired the property on which the mounds are in 1857, and died in 1862. The pipes were found at the time of Mr. O. T. Prince's tenure of the property, by two colored men who were digging a ditch near one of the smaller mounds of the group—the one marked M on our survey.

These pipes were held for a long time in the Prince family, and were shown, with certain other relics, before a scientific society in 1875, when a photograph of them was made (Fig. 1). Later, one of the pipes was disposed of and, fortunately, fell into the hands of Gen. Gates P. Thruston, who describes and figures it.[1]

FIG. 1.—Antiquities found at Moundville.

Two of the pipes shown, and one that was excluded from the photograph on account of its inferior condition, with equal good fortune to science, were procured by Professor F. W. Putnam, for Peabody Museum, Cambridge, Mass. They are shown in Figs. 2, 3, from photographs kindly furnished by Professor Putnam.

At the time the pipes went to Cambridge, a stone disc, 8.75 inches in diameter, found in the level ground at Moundville, was disposed of to Professor Putnam and is shown here in Fig. 4, from a photograph also courteously furnished by him. A reproduction of a drawing of the design on the disc, made by Mr. C. C. Willoughby, is given in Fig. 5. Mr. Willoughby informs us that a part of the design at the

[1] "Antiquities of Tennessee," p. 187.

FIG. 2.—Effigy-pipes of stone. Moundville.

FIG. 3.—Effigy-pipes of stone. Side view. Moundville.

lower left hand side has scaled off. The dotted lines show where the stone has come off in thin flakes. The design is apparent on the stone in these places, but it lacks distinctness.

Some years ago, a colored man, ploughing near one of the larger mounds at Moundville, found a superb hatchet and handle carved from a solid mass, probably amphibolite,[1] and highly polished. This hatchet (Fig. 6) was procured by Mr. C. S. Prince, from whom it was obtained by the Academy of Natural Sciences.

FIG. 4.—Disc of stone. Moundville. (Diameter 8.75 inches.)

The hatchet, 11.6 inches in length, with a neatly made ring at the end of the handle (not clearly shown in the reproduction), resembles, to a certain extent, the one found by Dr. Joseph Jones, near Nashville, Tenn., and described and figured

[1] All determinations of rock in this paper and in the three which follow it, have been made by Dr. E. Goldsmith, of the Academy of Natural Sciences of Philadelphia. As it has not been deemed advisable to mutilate specimens for analysis and for microscopical examination, Doctor Goldsmith has not always been able to identify materials with the exactness he otherwise could.

by him.[1] C. C. Jones describes and figures[2] this same hatchet, and speaks of the finding of another exactly similar in South Carolina.

Thruston also describes and illustrates[3] the Jones hatchet, and refers to the South Carolina specimen, and to still another, somewhat ruder in form, as coming from Arkansas.

It is interesting in this connection to note the presence of "celts" with stone handles in Santo Domingo,[4] though these hatchets are much inferior to the specimen from Moundville.

FIG. 5.—Design on disc from Moundville. (Half size.)

The monolithic hatchet from Moundville seems to be much more beautiful than the one discovered by Doctor Jones, for it leaves nothing to be desired as to finish, and the graceful backward curve of the part of the handle above the blade seems more artistic than the form of the corresponding portion of the Jones hatchet, which is straight.

Some years ago Prof. E. A. Smith, State Geologist of Alabama, visited Mound-

[1] "Explorations of the Aboriginal Remains of Tennessee," p. 46.
[2] "Antiquities of the Southern Indians," p. 280; Plate XII.
[3] *Op. cit.*, p. 259.
[4] J. Walter Fewkes, "Preliminary Report on an Archæological Trip to the West Indies," Smithsonian Miscellaneous Collections, Quarterly Issue, Vol. I, 1904. Plate XXXIX.

FIG. 6.—Monolithic hatchet from Moundville. (Length 11.6 inches.)

ville and received as a gift a disc about 12.5 inches in diameter, said to be of sandstone, of the same well-known type[1] as the one referred to as being in Peabody Museum. This type is characterized by marginal notches or scallops usually with incised, circular lines on one side below them. The disc obtained by Professor Smith, however, like the one in the Peabody Museum, has an interesting incised

FIG. 7.—Disc of stone from Moundville. (Diameter about 12.5 inches.)

decoration on the side opposite that bearing the incised circles, in which it differs from the ordinary discs of this type. The disc in question has on the reverse side an incised design of two horned rattlesnakes knotted, forming a circle,[2] within

[1] Rau, Archæological Collection of the United States National Museum, p. 37 *et seq.* Also Holmes, "Art in Shell," Second Rep. Bur. Eth., 1880–81, Plate LVII, p. 277 *et seq.*

[2] Our friend Señor Juan B. Ambrosetti, Curator of the National Museum, Buenos Aires, who, it may be said, incidentally, has been much impressed by certain points of resemblance in the aboriginal culture of Argentina and that of the United States, in his "El Bronce en la Region Calchaquí," Anales del Museo Nacional de Buenos Aires, Tomo XI (Ser. 3ª, t. IV), pp. 286, 287, describes and figures a disc of bronze, 33½ cm. in diameter, now in the National Museum of Buenos Aires, around the margin of which two serpents form a circle.

which is a representation of an open human hand bearing an eye upon it. This disc was lent to the National Museum, where it remained a long time, but is at present in the Museum of the University of Alabama, near Tuscaloosa, where we had the pleasure of examining it in company of Professor Smith, through whose kindness and that of Mr. James A. Anderson of the Geological Survey of Alabama we are able to give a photographic reproduction of it (Fig. 7). This interesting disc is described and figured by Professor Holmes,[1] who, as any cautious archæologist would have done at that time, rather discredited its genuineness. In view of discoveries made since, however, the disc may be accepted without suspicion, and such is Professor Holmes' opinion at the present time.

FIG. 8.—Water-bottle from Moundville. (Diameter 6.12 inches.)

In the museum of the University of Alabama, near Tuscaloosa, is part of a water-bottle, said to have been found at Carthage, which place, the reader will recall, is now known as Moundville. This vessel,[2] which was courteously lent to the Academy of Natural Sciences by Prof. E. A. Smith and Mr. James A. Anderson, and is shown in Fig. 8, bears upon the base an incised design. Around the body of the vessel, which is somewhat broken, have been four designs similar, in the main, to

[1] *Op. cit.*, p. 278, Plate LXVI, fig. 6.

[2] All measurements of earthenware vessels given in this report and in the three papers which follow it are approximate.

We quote from our preceding reports: "It must be borne in mind in respect to process work that reductions in size are made with regard to diameter and not area. If a diagram 4 inches by 2 inches is to be reduced one-half, each diameter is divided by two, and the reproduction, which is called half size, is two inches by one inch. The area of the original diagram, however, is eight square inches, while that of the so-called half size reproduction is two square inches or one-quarter the area." In other words the reduction is linear.

that on the base. One of these designs is given in diagram[1] in Fig. 9. Near the head, in certain instances, where space has allowed it (Fig. 10), and on each tail, is a swastika enclosed within a circle. Professor Putnam writes us "This design [the bird-figure] shows the characteristic duplication of parts in a most interesting manner. In the centre of the figure we notice the symbol which is common to many of the shell gorgets from Tennessee and which corresponds to the symbol on the Korean flag as well as to the well-known Chinese symbol indicating the positive and negative, or male and female." Professor Putnam next points out how, from this central symbol two heads of a bird which he identifies as a woodpecker, extend

FIG. 9.—Vessel from Moundville. Decoration. (About half size.)

FIG. 10.—Vessel from Moundville. Decoration. (About half size.)

and how on each side of these heads a symbolical wing of the bird is seen. Then on the right and left of the central portion are two tails of the bird, on each of which is the symbol of the swastika. "Altogether," says Professor Putnam, referring to the whole design, "this is a beautiful symbolic figure and in general workmanship and design it resembles some of the sculptures on bone from the Ohio mounds."

The bird shown in the design has been identified by Mr. Witmer Stone, of the Academy of Natural Sciences, as the ivory-billed woodpecker (*Campephilus principalis* Linn.), a bird now found in one part of Mississippi and in parts of Florida, but having ranged well north of Moundville in former times. The aboriginal artist shows the tongue of the bird extended to a somewhat exaggerated degree, although the thrusting out of the tongue is a habit common to woodpeckers. Emerging from within the open bill are various symbols, perhaps emblematic of bird-speech. The call of the ivory-billed woodpecker resembles that of a young child, according to Wilson.

The tail of the woodpecker, when spread, is fan-shaped and the individual feathers at the extremity are pointed—peculiarities carefully shown by the aboriginal artist. When spread, the tail of the woodpecker is used by the bird to

[1] It may be said here, as applying to these diagrams and others of the Moundville specimens, that proportions have been so far modified as was necessary to portray a curved field on a flat surface, though otherwise the representation is exact.

prop itself up and thus steady it at its work. This feature would no doubt strike the aboriginal eye and thus cause it to attach more importance to the tail of the woodpecker than to its wings.

Among the wonderful objects of wood found by Cushing at the settlement of Marco, Island of Marco, one of the Ten Thousand Islands, which lie off the southwestern Florida coast, is the picture of a bird painted in colors on a tablet of wood.[1] Mr. Cushing believes the painting to be that of a jay or kingfisher, "or more probably still, of a crested mythic bird or bird-god, combining attributes of both." Four contiguous circles in line are represented as leaving the open bill of this bird, which Mr. Cushing believes to be speech symbols.

The ivory-billed woodpecker was held in high esteem by the aborigines. Its head, modelled in gold, has been found in Florida.[2] Catesby[3] tells us that "the Bills of these Birds are much valued by the *Canada Indians*, who make Coronets of 'em for their Princes and great warriers, by fixing them round a wreath, with their points outward. The *Northern Indians* having none of these Birds in their cold country, purchase them of the Southern People at the price of two, and sometimes three Buck-skins a Bill."

We shall now describe our digging at Moundville, with certain details discussed in advance, to avoid repetition.

This work occupied thirty-five days with thirteen trained diggers from our boat and five men to supervise. In addition, local help, ten men per day on an average, was employed, mainly to fill excavations and to sink trial-holes in the summit plateaus of the mounds. Long experience had shown us that square and oblong mounds, in the south at least, were not designed primarily as burial mounds, although sometimes burials were made in them, locally, in graves dug from the surface. These trial-holes, averaging four feet square and four feet deep, when made in sufficient number on the plateau of a mound, were considered to be an excellent method of detecting the presence of burials, for, although the entire surface of the plateau was not dug through, it was extremely unlikely that skeletons or bundles of bones could all lie in an area not dug into by at least one of a number of well distributed shafts. When the presence of human bones was detected, more complete methods of investigation were adopted.

The material of which the mounds were made was clay, clay with admixture of sand, and, in places, to a limited extent, almost pure sand. On the whole, however, the mounds were chiefly of clay with an admixture of sand, often a very small percentage.

Inside as well as outside the circle, on the level ground, were many sites giving evidence of aboriginal occupancy. These sites were more or less thoroughly investigated by us by means of trial-holes. These holes were not always as deep

[1] Proceedings of the American Philosophical Society, Phila., Vol. XXXV, No. 153, Plate XXXIV, p. 98 *et seq.*

[2] Rau, Smithsonian Report, 1878, p. 299.

[3] "The Natural History of Carolina, Florida and the Bahama Islands," London, 1731, Vol. I, p. 16.

as those that we dug into the mounds, since, when undisturbed soil was reached, continuance was unnecessary. In our report we give records only of sites where tangible results were obtained. In some sites no burials were met; in others, burials were few and without artifacts.

The form of burial at Moundville did not include urn-burial so far as we were able to determine, but did not vary otherwise from methods of burial found in various southern states. When the entire skeleton was present, as a general rule it lay at full length on the back. There was no orientation of skeletons, the skulls being directed toward all points of the compass. Had it been otherwise, our fortune at Moundville would have been better, as vessels of earthenware almost always lay near the skull, hence by following the skeleton from the feet up, we could have reached these vessels with the aid of a trowel rather than, as was too often the case, by unintentional blows from a spade.

All human remains at Moundville were badly decayed and nearly all were represented by fragments only. No crania were saved.

Parts of crania found by us were carefully examined for evidence of antemortem compression, but none was met with, save in one case where it seemed to us to be evident. This fragment, the anterior part of a skull, was sent by us to the National Museum. The following report as to the fragment was received from Dr. Ales Hrdlicka: "The skull shows in a moderate degree an artificial frontal flattening. This variety of deformation was produced when an infant, by the prolonged application of a direct pressure (pad or board) over the forehead, a custom which existed in several of the Gulf States." Therefore, frontal flattening was not unknown at Moundville. It must be borne in mind, also, that as the crania examined were usually in small fragments, evidence of compression in many could well have escaped us.

The earthenware of Moundville is shell-tempered as a rule, but not always. In large cooking vessels the particles of shell are coarse and show on the surface. In the better ware the pounded shell is less noticeable, because it is more finely ground and for the reason that the Moundville ware, except in the case of cooking-vessels, is almost invariably covered with a coating of black, more or less highly polished on the outer surface. This coating was not produced by the heat in firing the clay, but was a mixture intentionally put on by the potters. Scrapings from the surface of a number of vessels were furnished by us to Harry F. Keller, Ph.D., who, by analysis, arrived at the conclusion that the black coating on the earthenware is carbonaceous matter. Under the microscope it appears as a lustrous coating, which must have been in a liquid state when applied. Chemicals have little effect upon the coating; it is insoluble in alcohol and in ether, not attacked by acids, and but slightly affected by caustic alkali. From its appearance and chemical behavior, Dr. Keller concludes that it must have been applied in the form of a tarry or bituminous matter which, upon heating out of contact with air, was converted into a dense variety of carbon. Doctor Keller is of opinion that a mixture of soot and fat or oil might produce the effect, though the numerous lustrous particles resembling graphite rather suggest the carbonization of a tar-like substance.

The earthenware of Moundville is characterized by monotony of form, the water-bottle, the bowl, and the pot being almost the sole representatives of the potter's art met with in its graves. It is to the striking incised decoration that we must look for the great interest attached to the earthenware of the place.

Stamped decoration was absent. Not only was the complicated stamp of the south Appalachian region, which extends across to southern Alabama, not met with in a single instance, but our old, intimate, and hitherto ever-present friend, the small check-stamp, was absent also.

The custom of perforating the base of vessels placed with the dead, in order to "kill" the vessels that their souls might be free to accompany the spirit of the departed, was not practised at Moundville, though it extended for a distance up the Tombigbee river, below its junction with the Black Warrior.

The reader will note in the detailed description of the discoveries at Moundville, which follows, that not one object met with by us, either through its method of manufacture or the material of which it was made, gave indication of influence of Europeans. The greatest pains were taken by us during the entire investigation to note the presence of any object obtained from the whites. Presumably, later Indians did not use Moundville as a center for burials.

All objects found at Moundville by us, with the exception of certain duplicates, which were sent to Phillips Academy Museum, Andover, Mass., are to be seen at the Academy of Natural Sciences of Philadelphia.

MOUNDVILLE.

Mound A.

Mound A, the central one of the Moundville group, about 22 feet in height and irregularly oblong in horizontal section, has a summit plateau 155 by 271 feet. Thirty-three trial-holes were sunk in the plateau, showing yellow clay with a slight admixture of sand. One small arrowhead of jasper alone rewarded our search.

Mound B.

Mound B, 57 feet in height, seems stupendous when viewed from the level ground. Two steep causeways, one at the north, the other at the east, lessen somewhat the angle of ascent, which, on the western side, is thirty-eight degrees. The summit plateau, roughly oblong, is 118 feet in width by 149 feet in length. Twenty-two trial-holes sunk by us yielded neither human bones nor artifact. The superficial part of the mound is of yellow clay with a small percentage of sand.

Field North of Mound B.

This field, probably between one and two acres in extent, and bordering the northern side of Mound B, is under cultivation and shows on its surface numerous traces of aboriginal occupancy. Eighteen trial-holes and 150 feet of narrow trench,

all about 2.5 feet deep, were excavated through loamy material to undisturbed soil. No human remains were encountered. The only object of interest met with among the usual midden debris was a hoe-shaped implement of granitic rock, 5 inches long by 4.75 inches wide. An attempt at perforation has been almost carried through on one side, but has been barely started on the other side (Fig. 11).

FIG. 11.—Ceremonial axe. Trench near Mound B. (Length 5 inches.)

In a paper by us, published in 1903,[1] we adduced considerable evidence to prove, what others had suggested before, that the so-called hoe-shaped implement is a ceremonial axe.

FIELD WEST OF MOUND B.

This field, lying directly to the west of Mound B, and considerably smaller than the one just described, was rather unpromising in appearance. Eight trial-holes gave no material result, and, from the appearance of the soil, no promise of success.

On the border of this field, overlooking a deep gully made by wash of rain, were several slight eminences consisting of a mixture of loamy sand and clay, in part washed away. These undulations, small, low, and of irregular shape, were thoroughly searched.

In a mingling of bones in which at least three adults and one child were represented, was Vessel No. 1, a small bowl with three protuberances on one side and three on the other—doubtless conventionalized head, tail, and four legs (Fig. 12).

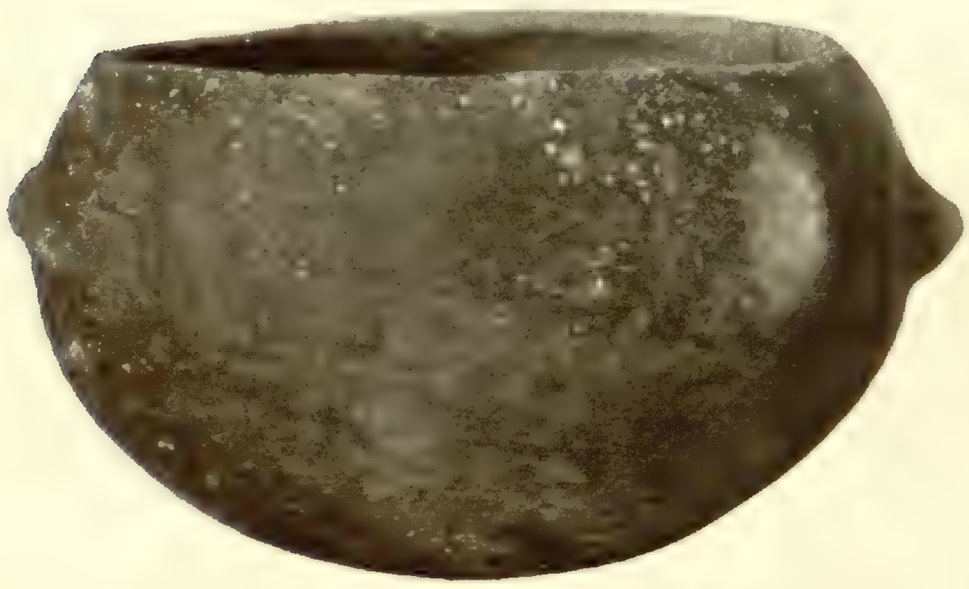


FIG. 12.—Vessel No. 1. Field west of Mound B. (Diameter 5.4 inches.)

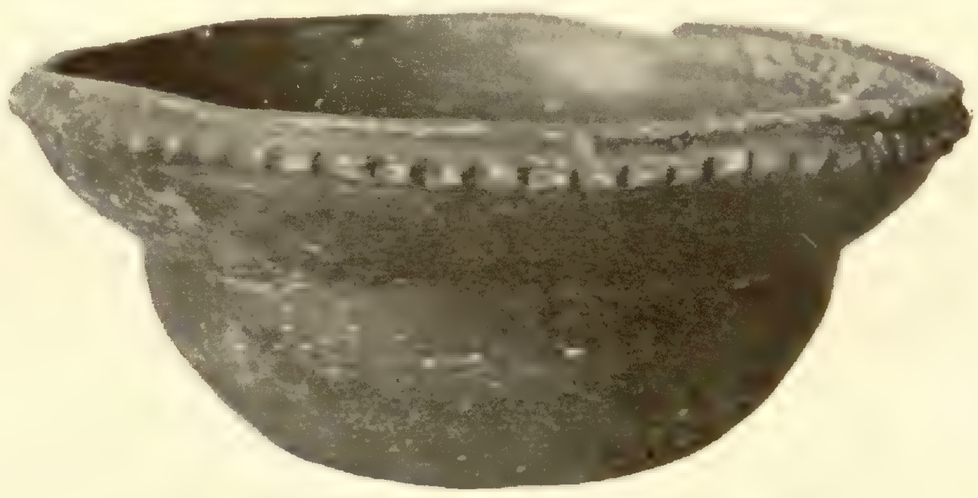


FIG. 13.—Vessel No. 3. Field west of Mound B. (Diameter 6 inches.)

[1] "The So-called 'Hoe-shaped Implement,'" Amer. Anthropologist, Vol. V, pp. 498–502, July–September, 1903.

Near Vessel No. 1 were Vessel No. 2 (a small, undecorated water-bottle with wide mouth), and a discoidal stone 1 inch in diameter.

Near the skull of a child, whose skeleton lay at full length on the back, was Vessel No. 3, a bowl with semiglobular body and flaring rim, undecorated save for a notched margin (Fig. 13).

Besides the usual midden debris there were in the soil, apart from human remains, a human head and the head of a fish, imitated in earthenware, which had formed parts of vessels; a rough arrowhead or knife, of chert; six discs made from potsherds, one very neatly rounded; and an interesting representation of a human hand, done in hard and polished earthenware, having two holes for suspension (Fig. 14).

FIG. 14.—Pendant of earthenware. Field west of Mound B. (Full size.)

MOUND C.

Mound C, overlooking the river, an irregular pentagon in horizontal section, has a basal circumference of about 485 feet while the circumference of its summit plateau is 295 feet. As the mound is on a decided slope, near land seemingly artificially depressed, and is bordered by a ravine on one side, the height is difficult to determine, varying locally between 9 feet and 20 feet, approximately.

Twenty-one trial-holes were sunk in the summit plateau, in some of which we came upon human remains almost at once.

In one hole, 4 feet down, was a bunched burial.

In another hole, 2 feet from the surface, was a single skull with a bunch of bones badly decayed and crushed. With these bones were a small quantity of mica and Vessel No. 1—a water-bottle painted red, with decoration in cream-colored paint (Fig. 15). Half of the decoration, which is similar to the other half, is shown in diagram in Fig. 16. This water-bottle proved to be the only vessel with painted decoration found by us at Moundville. Near it was Vessel No. 2 in fragments. This vessel, a cup, since put together, has a rather rude, incised decoration shown in Fig. 17. In the same hole, 3 feet distant, were small fragments of human bone and bits of pottery.

From other excavations came the usual hones, pebble-hammers, and bits of pottery, and two shells.

While digging the trial-holes it was noticed that no human remains were discovered in the southern half of the plateau, and that the soil of almost the entire northern half of the plateau was blackened with admixture of organic matter. With these facts in mind, we determined to dig superficially that part of the plateau which seemed to promise favorable results, but first it was decided to get some idea as to the body of the mound by an excavation of considerable size. Consequently an excavation 24 feet square, near the central part of the plateau, was carried to a depth of 16.5 feet, or 1 foot below previously undisturbed ground, where the excavation had converged to dimensions of 14 feet by 16 feet. A small hole, carried

FIG. 15.—Vessel No. 1. Mound C. (Height 8 inches.)

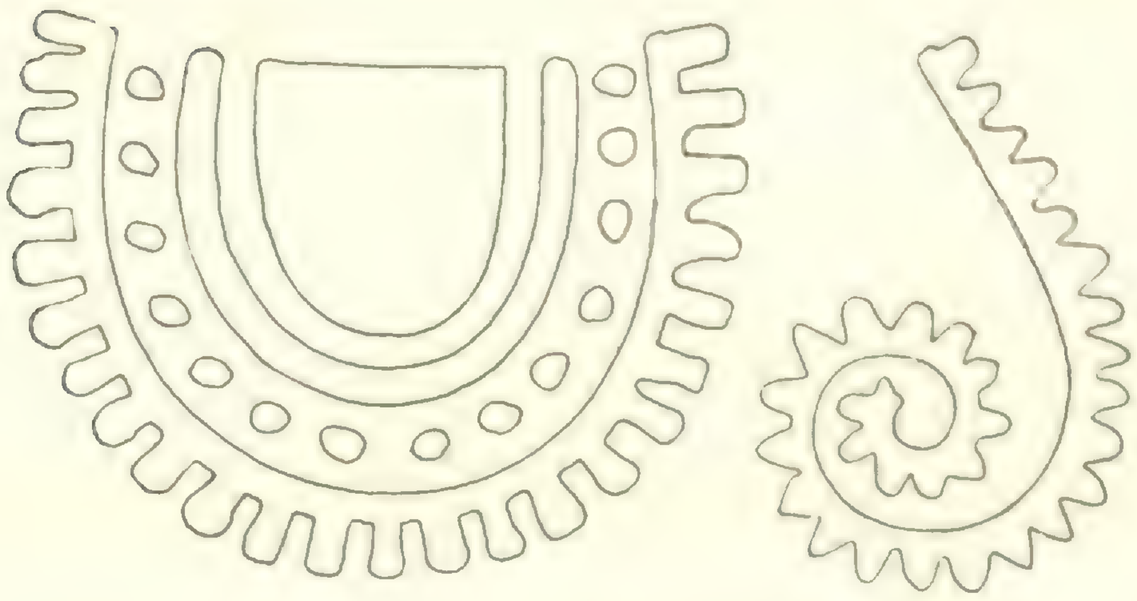


FIG. 16.—Vessel No. 1. Decoration. Mound C. (About half size.)

FIG. 17.—Vessel No. 2. Mound C. (Diameter 4 inches.)

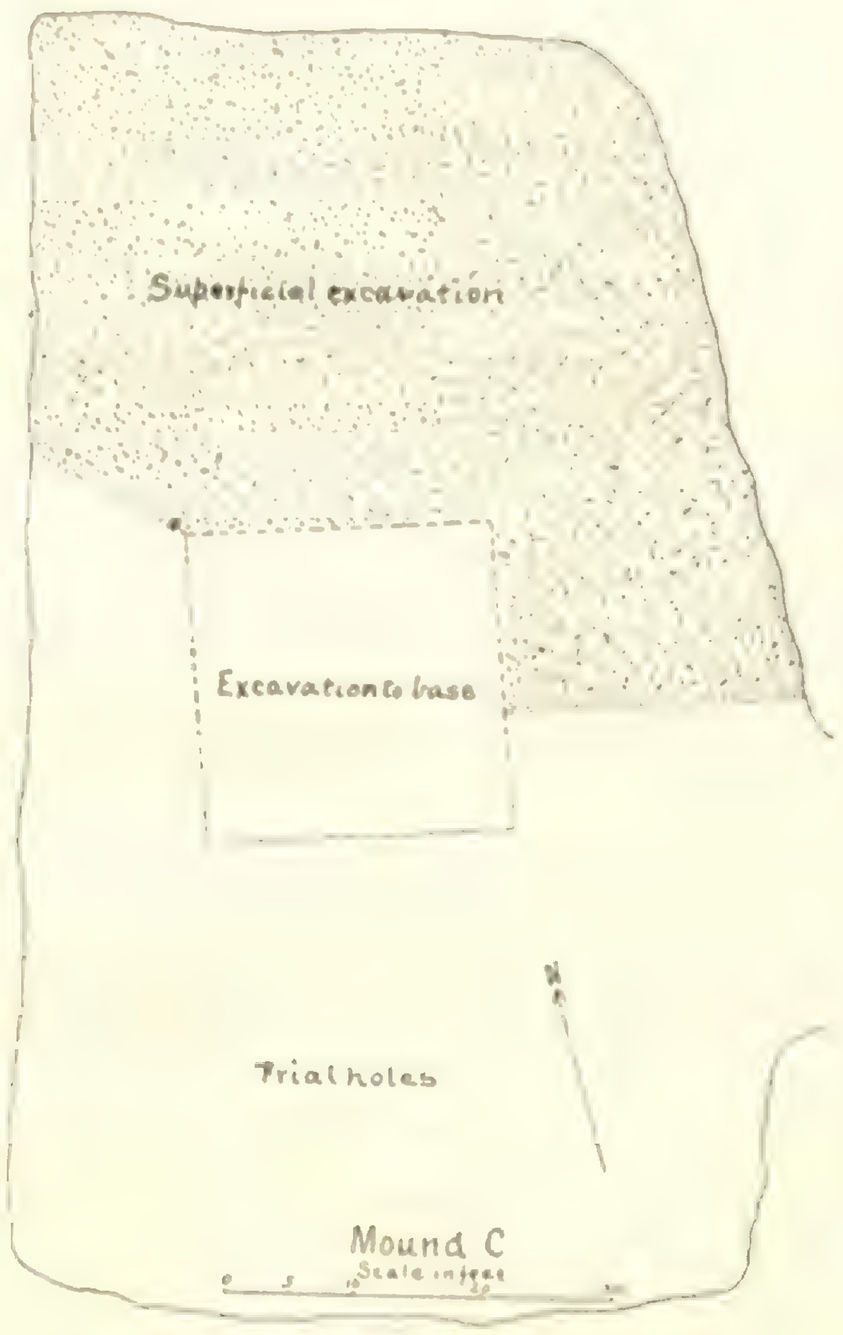


FIG. 18.—Plan of excavations. Mound C.

considerably deeper, substantiated our belief that the base of the mound had been reached. A plan showing the excavation and the superficial work done by us in this mound is given in Fig. 18.

In the northeastern part of the great excavation burials were met with at a depth of from 2.5 feet to 4.5 feet.

Two and one-half feet from the surface, with no burial remaining, was a handsome disc of metamorphic gneiss, 10.25 inches in diameter, with scalloped rim and with incised decoration on one side only (Fig. 19). On one side of the disc are traces of paint.

In an earlier part of this report we have described the finding of two stone discs at Moundville, previous to our visit, and have given references to works in which the area of distribution of large stone discs and slabs is described and their probable use discussed. Stone discs and slabs[1] were found by us on many occasions at Moundville, as will be noted in this report, and in each case the disc or the slab was more or less thickly smeared with paint, sometimes cream-colored, sometimes

[1] Compare, Jesse Walter Fewkes, "Two Summers' Work in Pueblo Ruins," 22nd Ann. Rep. Bur. Am. Eth., Part I, p. 185 *et seq.*, where ceremonial slabs found in Arizona are described.

red. The cream-colored paint upon one of the discs, analyzed by Dr. H. F. Keller, proved to be an impure white-lead. White-lead, as the reader is aware, is lead carbonate and of the same composition as the incrustation frequently found on the sulphide ore of lead. Masses of galena (lead sulphide) are often found in the mounds,

FIG. 19.—Stone disc. Mound C. (Diameter 10.25 inches.)

and as the reader will see, such masses were met with by us at Moundville. According to Dr. Keller, even a careful quantitative analysis of the carbonate deposit from galena would not show whether it was originally the manufactured pigment or the

native carbonate; therefore we cannot determine chemically whether or not the paint on the disc is European white-lead.

It is out of the question to suppose that aborigines manufactured white-lead from the sulphide ore, the process being too complicated, necessitating, as it does, the reduction of the sulphide ore to metallic lead and the production of the carbonate paint from the metal. Therefore, as to the provenance of this paint we have three hypotheses:

1. That the paint was made by Europeans.

2. That the paint is carbonate of lead scraped by the aborigines from masses of galena.

3. That the paint, originally of silver color, was ground from masses of galena and that this finely-ground lead sulphide, during long lapse of time in the mounds, became the carbonate. This hypothesis is strengthened by the fact that in very many cases we have found masses of galena in the mounds presenting facets produced by rubbing, and in some cases hollows probably made in the same way. Doctor Keller, however, is of opinion that paint made in this way would show, at the present time, glittering particles of galena that had not undergone change.

As the result of our investigations, we believe the foregoing to be the only ways of accounting for the presence of white-lead in the mounds. In view of the fact that no object surely of European provenance was found in the mounds or cemeteries of Moundville, and the knowledge that the aborigines had the material at hand to manufacture a lead paint with the aid of bear's grease, it seems conclusive to us that the paint on the discs and slabs is purely of aboriginal origin.

The universal presence of paint upon these discs and slabs seems to offer a clue to the purpose for which they were used, and, until a better suggestion is offered, we shall consider them palettes for the mixing of paint.

Beneath this disc in Mound C were three vessels, two badly crushed (Vessels Nos. 3 and 4), the third (Vessel No. 5), with a handle broken and missing, having an incised scroll decoration of a pattern to be figured several times in other parts of this report

Vessel No. 3, when pieced together, proved to be a broad-mouthed water-bottle decorated with a kind of incised meander in a cross-hatched field (Fig. 20).

Vessel No. 4, repaired and partly restored (Fig. 21), has around the body eight incised open hands alternately pointing upward and downward. On each hand is an open eye. Part of this design is shown in diagram in Fig. 22.

Thirty inches from the surface were friable fragments of sheet-copper corroded through and through.

Many shell beads and bits of sheet-copper lay with a fragment of a tibia, about 3 feet from the surface.

A skeleton at full length, about 3 feet down, had on one side of the skull a copper ear-plug of the usual type, and on the chest the crumbling remains of what must have been a sheet-copper ornament of considerable size.

A trifle more than 3 feet from the surface was a skeleton at full length on the

FIG. 20.—Vessel No. 3. Mound C. (Height 5.4 inches.)

FIG. 21.—Vessel No. 4. Mound C. (Diameter 5.7 inches.)

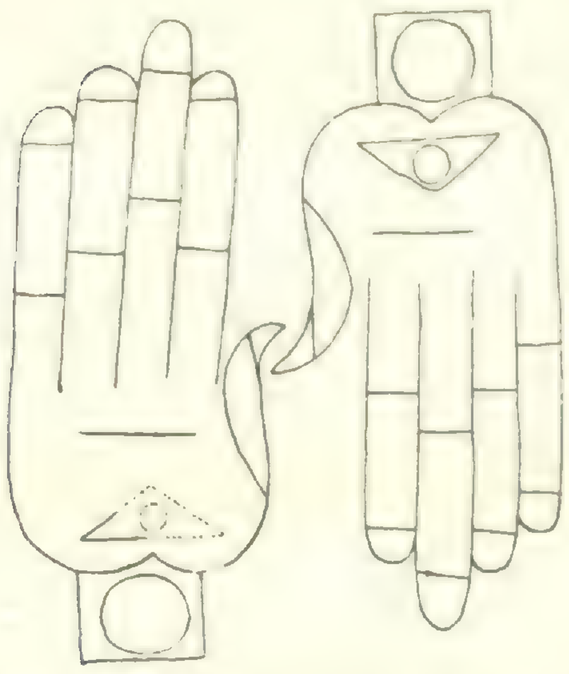


FIG. 22.—Vessel No. 4. Decoration. Mound C. (About half size.)

back, with fragments of sheet-copper at the head and a few bits on the upper part of the chest. At both knees were beads, some round, some tubular, each about half an inch in length. At each ankle, on the outer side, was a deposit of small, spherical pebbles that evidently belonged to rattles. A small quantity of mica lay near one knee.

A skeleton at full length on the back, at about the same depth as the last, had near the head a drill-point wrought from a jasper pebble, and a disc of metamorphic gneiss (Fig. 23), 7.8 inches in diameter, with an oblong slab of sedimentary rock, 4.75 inches broad by 5.75 inches long, beside it (Fig. 24).

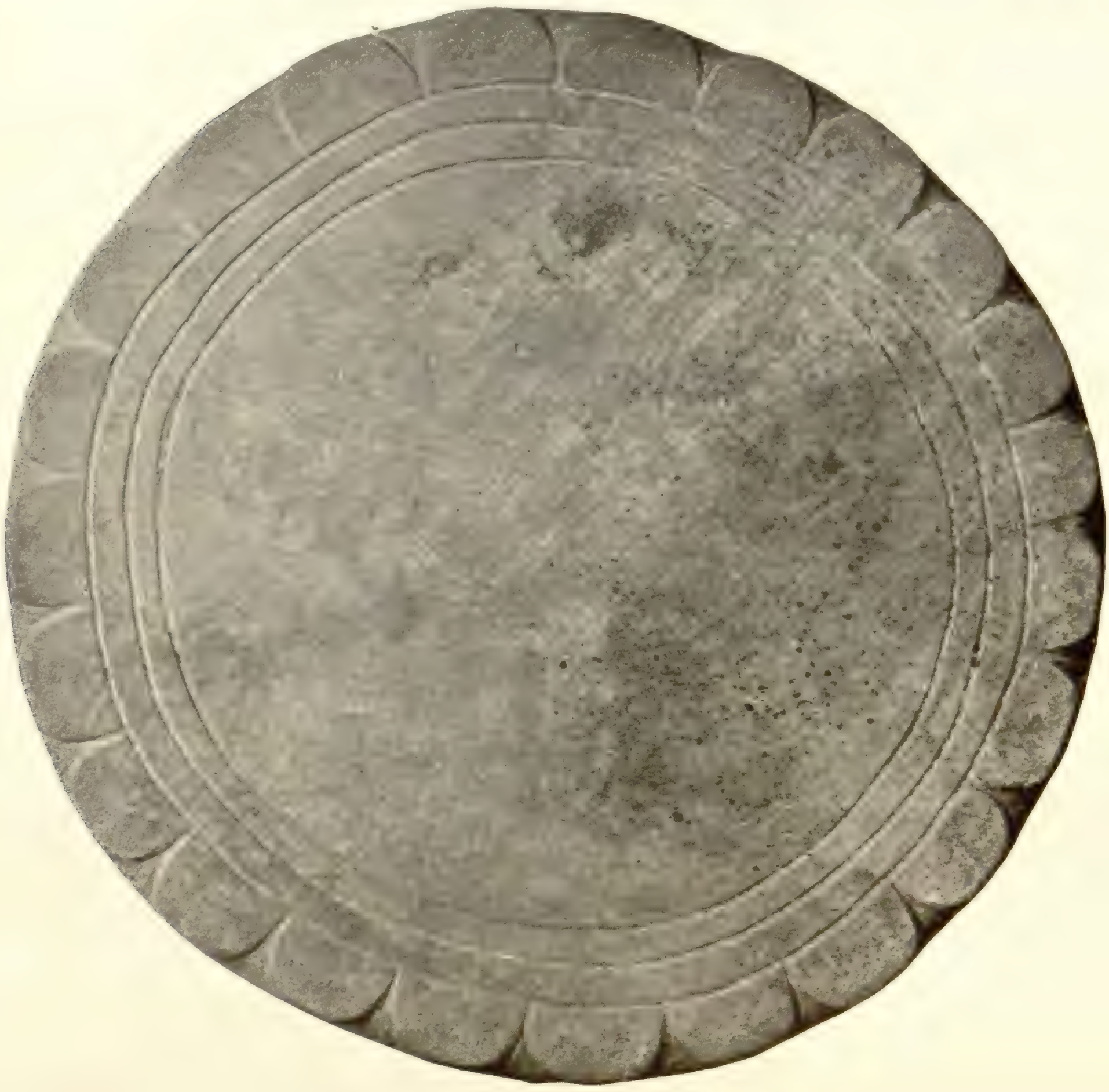


FIG. 23.—Stone disc. Mound C. (Diameter 7.8 inches.)

Resting on these two was another disc of metamorphic gneiss, of the same diameter as the other. The whole deposit was covered with decayed wood. The discs, somewhat crushed, have been repaired. On each are traces of pigment. Neither on these discs and slabs nor on any others found by us at Moundville was there incised decoration on both sides; and on neither side had an attempt been made to represent figures.

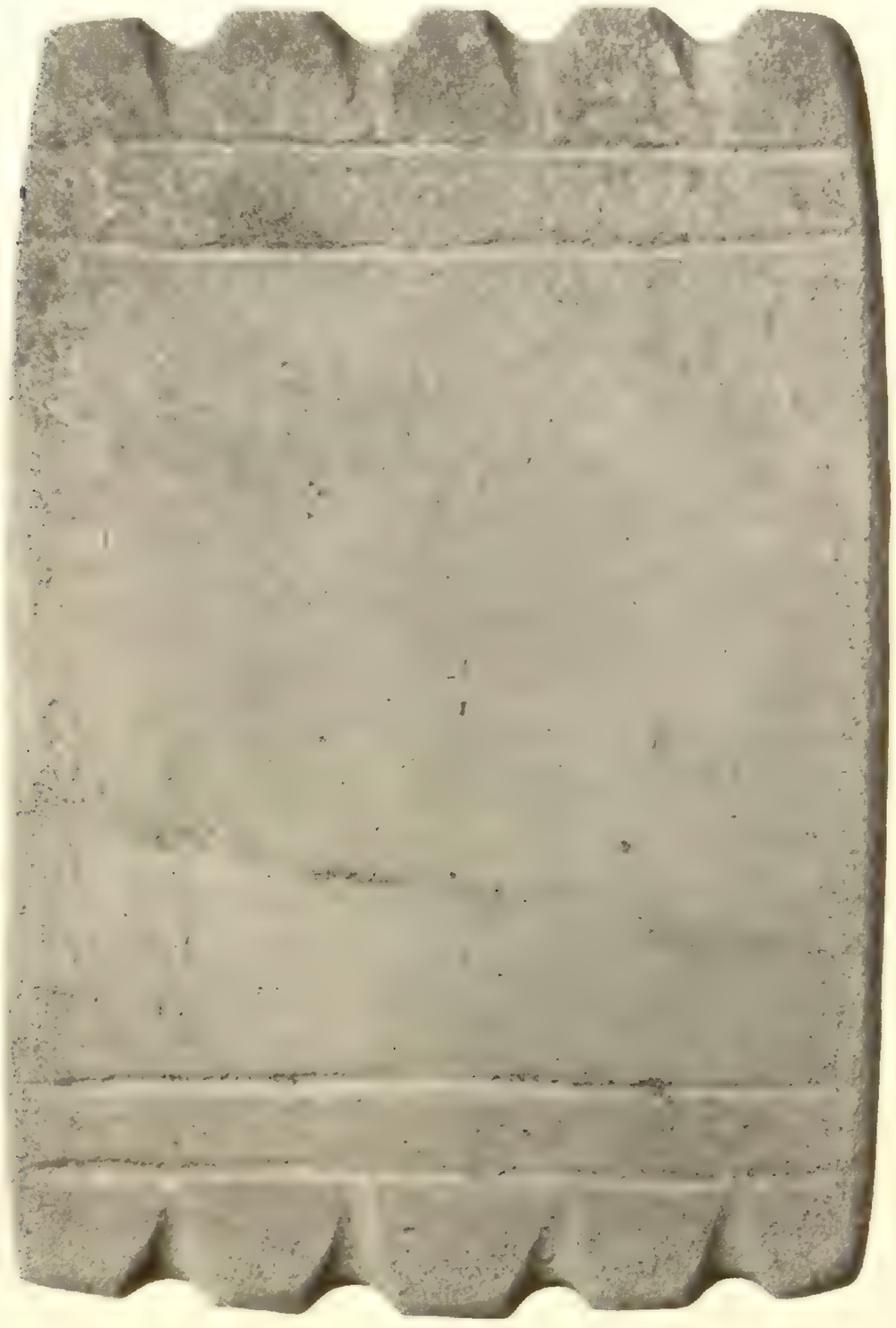


FIG. 24.—Stone slab. Mound C.
(Length 5.75 inches.)

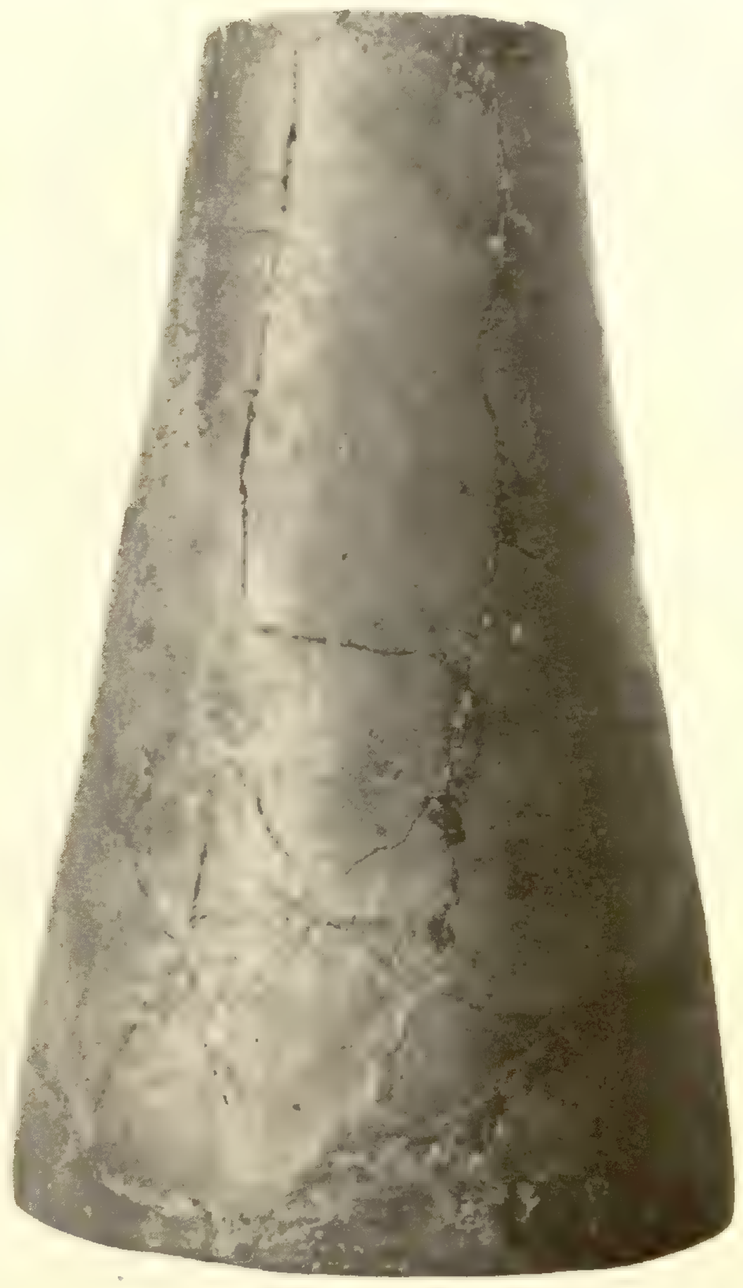


FIG. 25.—Vessel No. 6. Mound C.
(Height 6.75 inches.)

Another skeleton at full length on the back lay at the same depth, with no artifacts in association; and not far distant, at a somewhat lower level, was still another burial of the same kind. Near the skull of the latter were fragments of of what seemingly had been a flat, tapering blade of sheet-copper, with the point and certain other parts remaining; also bits of corroded sheet-copper belonging to one or more ornaments, with fragments of matting. Nearby was a thin, even, oblong layer, of small, spherical pebbles, covering a space 8 by 10 inches in extent, enclosed above and below in a black substance decayed beyond recognition. With these pebbles, was a diminutive disc of earthenware or soft clay-stone, having a circular marking in the center on one side.

At 52 and 56 inches from the surface, respectively, were a bunch of loosely-spread bones, including one skull, and a skull lying alone. With the bunch was a small quantity of mica.

Vessel No. 6 lay in fragments in the wall of the excavation and presumably belonged to human remains that had been removed. Pieced together, the vessel proved to be a truncated cone in shape (Fig. 25).

FIG. 26.—Ceremonial axe of stone. Mound C. (Length 6.5 inches.)

When the great excavation, in the northeastern part of which lay the burials and relics we have just described, had reached a depth of 6.5 feet, a change in the material of which the mound was composed was noted, the upper part having been brown and red-brown clay with an admixture of sand and organic matter here and there. While there had been more or less stratification in places in the upper part, the material in the main was homogeneous. Below this level of 6.5 feet from the surface, the mound was more stratified, and the clay contained much less sand and was of various shades of gray. It became evident that we had reached a level which, at an earlier period, had been part of a summit plateau of the mound. Confirming this view, various pits were discovered, each extending from this lower level several feet down into the mound. In two of these pits were human remains. In one, 4.5 feet below this lower, or original plateau, were crowns of teeth and a line of bones in the last stage of decay. In another pit, 5 feet across and 34 inches down from this former summit plateau, teeth and a line of decayed bones again were present. A number of similar pits were noted by us, but either the bones had entirely disappeared through decay or the fragments were so small that they were thrown back before the presence of the pit was discovered. One pit, with a layer of decayed bark along its base, was disturbed by our men while we were absent from that part of the mound. In this instance bones may have been present, but if so their fragments were too minute to attract attention in the dirt thrown out.

In the clay taken from the excavation at a depth of about 8.5 feet from the second, or present, summit plateau of the mound, or 2 feet below the lower level, was an imitation in wood copper-coated, of a canine of a large carnivore, with a perforation at one end for suspension. This ornament, 2.75 inches in length, had been wrapped in matting, some of which remained.

At a depth of 9.5 feet from the upper level, or 3 feet below the lower one, where certain pits were, was an interesting ceremonial axe of plutonic rock, with flaring edge, about 6.5 inches in length (Fig. 26). This axe, which much resembles one found by us in the famous mound at Mt. Royal, Florida, had red oxide of iron adhering to it at one place. About 2 inches of the upper part, away from the blade, where the handle had been, was not polished like the rest of the implement, being finished more or less in the rough.

Perhaps a recapitulation of the results of this excavation may not be out of place.

We have here a mound 15.5 feet high at the central part, which originally had a height of but 9 feet. It was occupied for a period while at the latter level, and burials were made in pits dug from its surface. Later, the height of the mound was increased by 6.5 feet, and the summit plateau of this enlarged mound was again used locally as a place for burials.

FIG. 27.—Ceremonial axe of copper, with part of handle in place. Mound C. (Full size.)

It was evident to us that the mound had undergone but two stages of occupancy, as there were no change in the material below the lower level of which we have spoken, and no sign of a pit having a beginning lower than this level 9 feet above the base.

It occurred to us, as a point of interest, carefully to note the earthenware from the lower part of this mound in order to learn whether or not a difference existed between it and the earthenware found above, but as no vessels were found in the original mound, and as but two small, undecorated sherds were obtained by our men there, means for comparison were wanting.

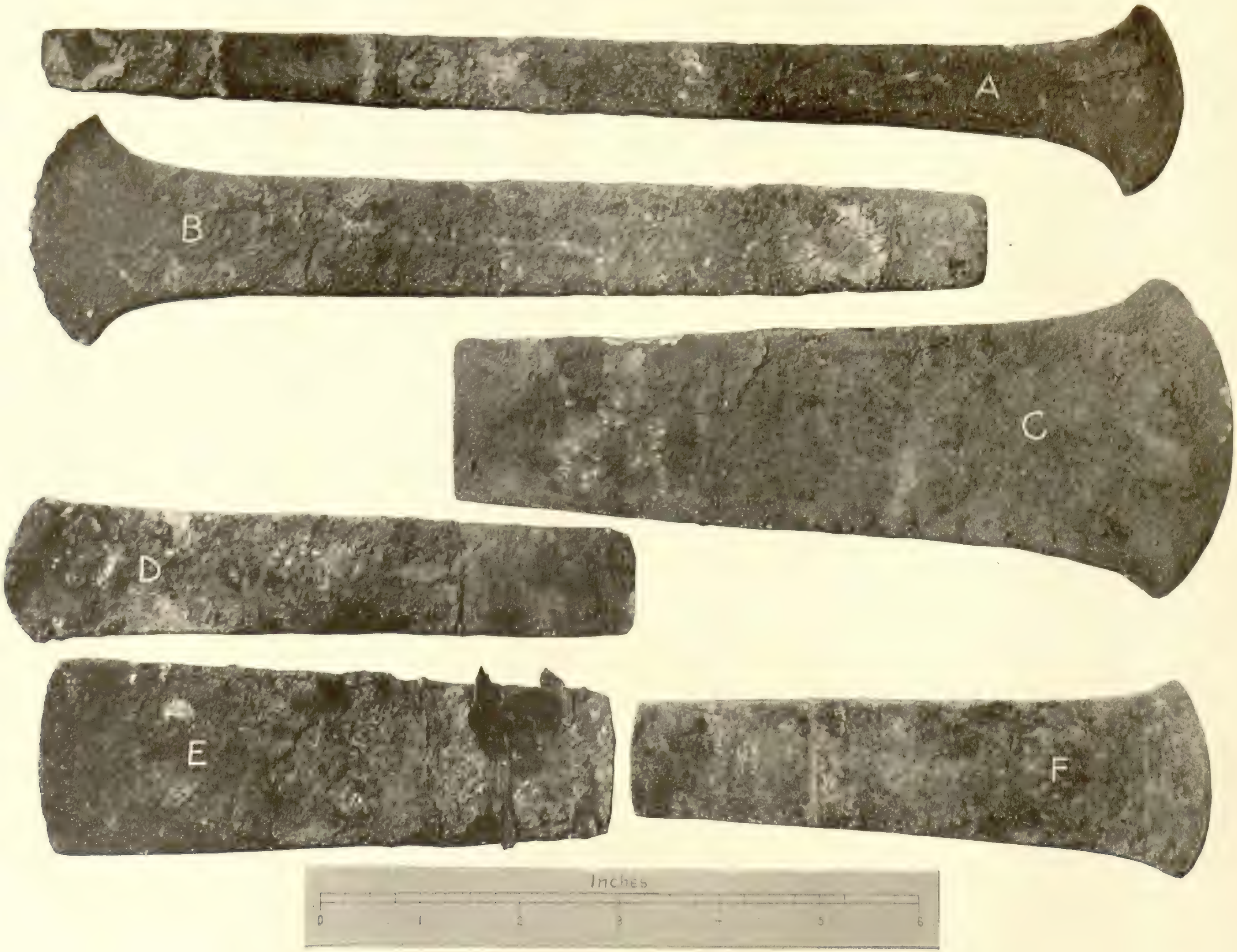


FIG. 28.—Ceremonial axes of copper. Moundville.

Having disposed of the deep excavation, we turned our attention to the northern part of the summit plateau of the mound through which we dug to a depth of fully 5 feet. The area excavated, as before said, is given in the plan showing the great excavation.

All burials, so far as could be determined, were in pits that had been dug from the surface, though often, on account of aboriginal disturbance, the exact limits of these pits could not be traced.

Four feet below the surface, with a few, soft fragments of human bone, was a ceremonial axe of copper, 8 inches long, 3 inches across the blade, and 1.75 to 2 inches broad in other parts. Remains of a wooden handle, 2 inches in width, still adhere to the metal, showing that 1 inch of the implement projected behind the handle (Fig. 27). C. C. Jones[1] describes a somewhat similar axe from Georgia and rightly places it in the ceremonial class, calling attention to its light weight and delicate structure.

A skeleton complete down to, and including, part of the thorax had, under the chin, small fragments of a sheet-copper ornament that had been encased in matting.

Near a femur, lying alone, was a considerable number of tubular shell beads, each somewhat less than 1 inch in length.

At a depth of 16 inches from the surface were certain scattered human bones near a small pocket of fragments of calcined bone, also human, with more unburnt bones beyond.

A skull and a few bones in disorder lay together. With the skull was Vessel No. 7, in fragments, and a small cup with incised, ribbon-fold decoration, resembling in form and in design Vessel No. 21 from this mound and Vessel No. 15 from Mound O.

In the same pit, but not immediately with the bones, was a ceremonial axe of copper, to which fragments of a wooden handle still adhered. This axe, like most copper objects found in the mounds, was encased in decayed material—wood, in this instance. The length of the axe is 6.4 inches; it is 1.5 inches across the blade, and 1 inch in breadth at the opposite end. The breadth of the space covered by the handle is 1.25 inches; 1.5 inches of the axe projected behind the handle (Fig. 28 D).

In this same pit lay a skeleton at full length on the back. At each side of the skull was an ear-plug of the ordinary form, made of wood, coated with sheet-copper on the upper surface. The companion parts of these ear-plugs, which were worn behind the lobes of the ears, were not found; presumably they had been made of some perishable material. Below the chin was an ornament of sheet-copper in small fragments which, put together, form in part a gorget with scalloped margin, having three roughly circular lines surrounding a swastika defined by excised portions (Fig. 29). Near the skull were Vessels Nos. 8 and 9, both crushed to fragments. Vessel No. 8, pieced together, bears an incised design several times found by us at

[1] "Antiquities of the Southern Indians," p. 226 *et seq.*

Moundville (Fig. 30). Vessel No. 9, repaired, shows an incised meander around the body (Fig. 31).

Near a dark stain in the soil, which possibly indicated where a skeleton had disappeared through decay, was a pendant of sheet-copper, encased in decayed wood. In the upper part are excisions to form a swastika, and an excised triangle below (Fig. 32). With this pendant were small fragments of another.

FIG. 29.—Part of sheet-copper gorget. Mound C. (Full size.)

In a pit in which were other bones, apart from artifacts, was a mass of galena about the size of a child's fist, with fragments of bone. This galena, or sulphide of lead, was heavily coated with carbonate of lead, which could readily be used as paint. In the same pit, but deeper, lying near a few small bits of skull, was a disc, probably of fine-grained gneiss, 16 inches in diameter, without decoration. Nearby, above the disc, were small fragments of sheet-copper and Vessel No. 9*a*, crushed to

FIG. 30.—Vessel No. 8. Mound C. (Height 7 inches.)

FIG. 31.—Vessel No. 9. Mound C. (Height 7 inches.)

FIG. 32.—Pendant of sheet-copper.
Mound C. (Full size.)

FIG. 33.—Ceremonial axe of copper. Mound C. (Length 13.75 inches.)

small fragments. With Vessel No. 9*a* was Vessel No. 10, also in fragments, which, cemented together, proved to be a small, wide-mouthed water-bottle with a scroll decoration on a cross-hatch field.

Somewhat more than 4.5 feet down was a dark line in the soil, perhaps the last trace of a decayed skeleton. With it, together, were two small masses of galena, minute fragments of sheet-copper, and a neatly made discoidal stone of quartz, 2 inches in diameter.

Slightly more than a foot below the surface was a small deposit of fragments of calcined human bones, accompanied with a little charcoal and burnt clay in small masses. It appeared as if these foreign substances had been gathered up with the bones at the place of cremation.

Near a dark line, probably left by decayed bones, was a ceremonial axe of copper, 13.75 inches long, 1.9 inches across the flaring blade, and .4 inch wide at the opposite end (Fig. 33). This implement, encased in wood, as usual, has no handle remaining upon it, but it plainly shows where a handle has been, with part of the body of the axe behind it.

Scattered fragments of calcined human bones, with part of one unburnt bone among them, lay 2 feet from the surface.

Remnants of a skull and part of a long-bone lay together; with them were fragments of corroded sheet-copper.

Apparently apart from human remains was an undecorated but gracefully shaped water-bottle (Vessel No. 11), which, unfortunately, received a blow from a spade.

Four feet from the surface, with a few fragments of human bone and many tubular shell-beads, each slightly less than an inch in length, was the remainder of what presumably had been a shell drinking-cup. Pieces separated through decay lay near it. The large fragment, which had upon it parts of two engraved fighting figures, received a blow from a spade, which, however, did no material harm, inasmuch as the parts separated by the blow had lost through decay all trace of engraving. That which remains of the engraved design shows what is left of two fighting figures. Below, a figure with parts of the trunk missing, as well as the legs and the lower part of the left arm, has the right arm upraised to strike with a weapon of some kind—perhaps a war-club. In the ear of this figure is represented a large ear-plug, and ornaments, probably copper, are on the head. The second figure is represented by a leg and part of a foot. An unidentifiable object, but perhaps the handle of an axe, is between the figures (Fig. 34).

Engraved figures on shell, of the same class[1] as those from Moundville, have been found in Missouri, in Tennessee, and in Georgia, and on copper in Georgia.

[1] W. H. Holmes, "Art in Shell," Second Rep. Bur. Eth., 1880–81; also same author in Smith. Misc. Col., Vol. XLV, Quarterly issue, Vol. I, Pt. I.
Thruston, "Antiquities of Tennessee," 2nd ed., chap. ix and supplement to chap. ix.
Thomas, in Fourth Rep. Bur. Eth., 1883–4, p. 100 *et seq.*
See also Starr, in Proc. Davenport Acad. Nat. Sci., Vol. VI, p. 173 *et seq.*
Saville, in Bul. Am. Mus. Nat. Hist., N. Y., Vol. XIII, p. 99 *et seq.*

Incidentally, it may be said that the statement made by Doctor Thomas that the famous Etowah plates show European influence, is not now accepted by competent judges.

With a lone skull was a beautiful, little bird arrow-head, of transparent quartz.

Vessel No. 12, in fragments, was found away from human remains, though in all probability bones buried with it had disappeared through decay, or perhaps the

FIG. 34.—Part of engraved shell. Mound C. (Full size.)

vessel had been cast aside in an aboriginal disturbance. This vessel, pieced together, shows a series of central crosses and a cross-hatch design (Fig. 35). Nearby lay a mass of galena (lead sulphide), showing many facets as if worked down for a specific purpose (Fig. 36).

Two burials, one above the other, which had been skeletons at full length, as

FIG. 35.—Vessel No. 12. Mound C. (Height 6.25 inches.)

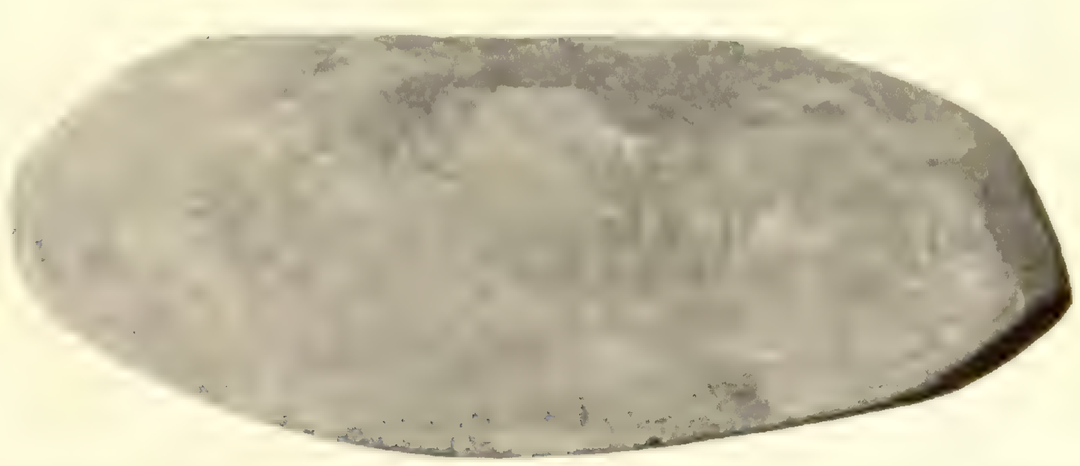


FIG. 36.—Mass of sulphide of lead showing the white carbonate used for paint. Mound C. (Full size.)

indicated by fragments of bone still remaining, had each a number of shell beads. A bit of sheet-copper lay not far away.

With an irregularly bunched burial was a small quantity of charcoal.

Vessel No. 13, a wide-mouthed water-bottle with numerous shallow depressions surrounded by incised line decoration (Fig. 37), a favorite pattern at Moundville, lay apart from any visible trace of human remains. Near where the vessel lay was an interesting fire-place that formed the base of the pit in which the vessel was found. This fire-place, having the form of a basin 11 inches deep and 40 inches in diameter, was made of clay, hardened and burnt red by fire to a thickness of 6 inches. On the bottom of the basin was a quantity of gray material mingled

FIG. 37.—Vessel No. 13. Mound C. (Height 6 inches.)

with clay; this was covered with a black substance 2.5 inches thick, possibly decayed vegetable matter. The gray material, analyzed by Dr. H. F. Keller, proved to consist "principally of carbonate of lime with admixed sea-sand. The color, a dirty brownish, is due to a hydrated oxide of manganese, of which the mixture contains a very notable amount. The brown specks are distinctly visible under the magnifying glass, and evolve chlorine from hydrochloric acid when the material is treated with this solvent."

Vessel No. 14, a broad-mouthed water-bottle, with rude, incised scroll decoration, lay in fragments, apart from human remains.

With a few fragments of bones of a child lay, one upon the other, what was left by decay and the blow of a spade, of two circular sheet-copper ornaments. In the center of each, four excised spaces form a swastika. On one of the discs are rows composed of many small pearls remaining as when strung (Fig. 38).

FIG. 38.—Gorget of sheet-copper with string of pearls. Mound C. (Full size.)

A highly-polished and beautifully made discoidal stone of brown and white conglomerate, presenting a striking appearance, lay apart from human remains.

With no bones visible nearby were Vessels No. 14a and No. 15, in fragments. Each of these is a broad-mouthed water-bottle with a decoration common at Moundville, having depressions in the body, surrounded by incised scroll-work.

Forty-five inches below the surface a great shell drinking-cup (*Fulgur perversum*), 13 inches in length, was found; and inverted over it was Vessel No. 16, a bowl with beaded margin, somewhat broken when unearthed. In the shell cup was a black substance in which was a splinter of bone, probably remains of food. We found similar material in a number of vessels at Moundville. Nearby was a well-made "celt" of volcanic stone and a wide-mouthed water-bottle (Vessel No. 17), in fragments. This vessel (Fig. 39), pieced together, bears on each side an incised meander surrounding small, shallow depressions. With this water-bottle was a coarse, brown-ware cooking vessel, with two loop-handles (Vessel No. 18).

FIG. 39.—Vessel No. 17. Mound C. (Height 5.9 inches.)

A broken shell drinking-cup, without decoration, lay apart from bones, so far as we could determine.

About 4 feet below the surface were a few human teeth, probably all that remained of an entire skeleton. Beneath the teeth, where the neck had been, was part of a pendant of much corroded sheet-copper, similar to one already illustrated (Fig. 32), as coming from this mound. At each side of the place where the head had been was an ear-plug of ordinary type, consisting of a disc of wood with sheet-copper on the outer side (Fig. 40). The parts which, placed behind

the lobes of the ears, held these ornaments in place, were not found, hence it is presumed they had been entirely of wood.

With some fragments of badly decayed bone was a ceremonial axe of copper, with part of the wooden handle still remaining upon it in fairly good condition, the wood maintaining a rounded surface. The length of this axe is 5.75 inches; width of blade, 2 inches. The blade projected .25 of an inch behind the handle (Fig. 28 F). Above this implement was a copper-coated bead of shell, somewhat broken.

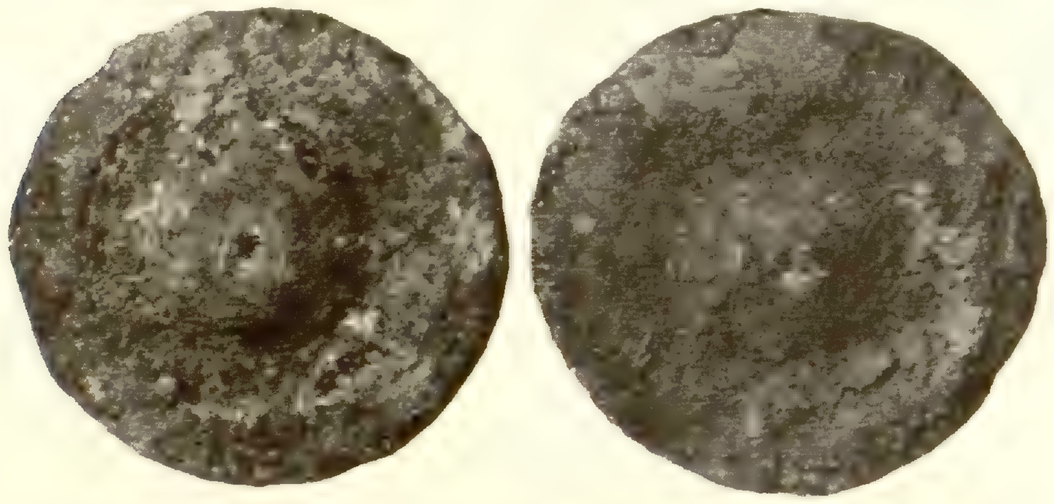


FIG. 40.—Wooden ear-plugs, copper-coated. Mound C. (Full size.)

A ceremonial axe of copper fell with caved material. Length, 7.8 inches; width of blade, 3.2 inches (Fig. 28 C). In the neighborhood from which the axe fell were fragments of what had been a large breast-piece of sheet-copper. Unfortunately the badly corroded state of the metal precluded any chance of recovering this ornament save in very minute fragments.

Somewhat below scattered fragments of bone in a pit, with bits of much decayed skeletal remains, were parts of what probably had been a hair-ornament of sheet-copper, similar to one to be described in connection with Burial No. 37 in this mound. With the fragments of this ornament was what Prof. F. A. Lucas kindly has identified as a strip of bison-horn. This material readily could have taken the place of a pin of bone. A similar strip of bison-horn lay with the hair-ornament near Burial No. 37.

Near the ceremonial axe and the breast-piece, but not with them, occurred a dark line in the soil, probably all that remained of a human skeleton. On this line was a ceremonial axe of copper, about 9.6 inches long and 2.25 inches across the flaring blade (Fig. 28 B). On the cutting edge is a series of nicks, or tally-marks, similar to those so often found on ceremonial objects. If farther proof were needed to assign these copper axes to the ceremonial class, these notches along the edge of the blade certainly would supply the deficiency.

Vessels Nos. 19 and 20, small, undecorated, broad-mouthed water-bottles, lay together, with no bones remaining in association.

A small deposit of fragments of calcined human bone lay 18 inches from the surface.

We now come to Burial No. 37, a most noteworthy one. Forty inches below the surface was a dark line, doubtless marking the former presence of a skeleton. Near the eastern extremity of this line were a few human teeth and part of a lower jaw. Assuming that this black line was almost the last trace of a skeleton that once lay at full length on its back, heading eastward (an assumption borne out by the position of the jaw and by finding the lower ends of the tibiæ and fibulæ at a

proper distance therefrom), we can say with reasonable accuracy where the objects found with this burial had been placed originally.

Forty-five globular beads of wood, copper-coated, each about 1.1 inch in diameter were around the ankles, the bones of which were preserved by the presence of the copper. With these beads were a few perforated pearls, the size of a pea and smaller.

Across the knees was a ceremonial axe of copper, about 11.5 inches in length and 1.9 inches across the flaring blade (Fig. 28 A).

At each wrist were sixteen copper-coated beads similar to the others.

At the lower part of the chest, the broad end with two perforations for suspension being toward the head, was a pendant of sheet-copper, about 6.75 inches in length, with excised parts forming a swastika and having a triangle cut out from the copper below (Fig. 41).

FIG. 41.—Pendant of sheet-copper. Mound C. (Full size.)

On the chest, below the chin, were two gorgets of sheet-copper, one lying on the other. The larger (Fig. 42), roughly circular, was uppermost. The smaller (Fig. 43), an eight-pointed star within a circle, still has cord in two perforations made for suspension. Below the chin was a number of small perforated pearls, badly decayed; and parts of several strings of pearls adhered to the larger gorget.

Under the head was a curious object of copper (Fig. 44), doubtless a hair-ornament, 14.5 inches in length, flat, pointed at each end, with a maximum width of .6 of an inch.

At the left side of the head was a curious hook-shaped ornament (Fig. 45), with a strip of bison-horn, which, presumably, had taken the place of a pin of bone. This hair-ornament is similar to one found with another burial in Mound C.

But the gem of the objects worn by this important personage who, perhaps, at

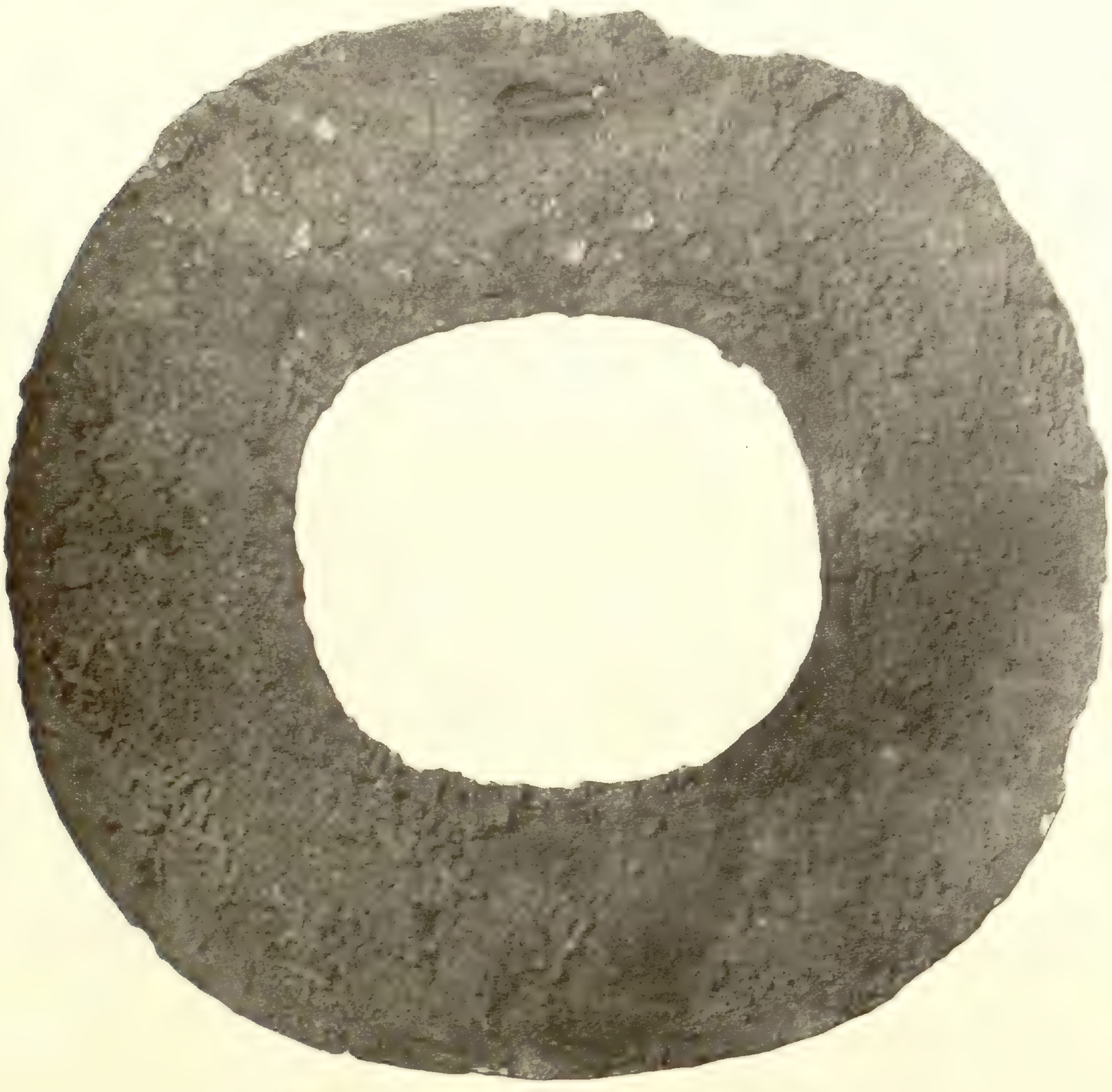


FIG. 42.—Gorget of sheet-copper. Mound C. (Full size.)

one time owned the great mound wherein he now figures as Burial No. 37, is an effigy of a human head (Fig. 46), which lay with the gorgets on the chest and, possibly, formed a center-piece to the annular one. This interesting little gem, carved from amethyst and perforated behind for attachment, is shown in four positions in Fig. 47.

Aboriginal work in amethyst is uncommon. We found a beautifully made pendant of amethystine quartz in the rich mound at Crystal river, Florida; and investigation under supervision of Mr. Warren K. Moorehead resulted in the discovery of a pendant of amethyst, somewhat more rudely made than ours, in southern Indiana.

Mr. George F. Kunz, who is so familiar with gems and hard stones, writes of this amethyst head: "The drilling was undoubtedly done by no other agents than quartz, either with a stick or a hollow reed; and the sawings by drawing a string or a thong across the object, using sand as an abrasive, possibly wet. The

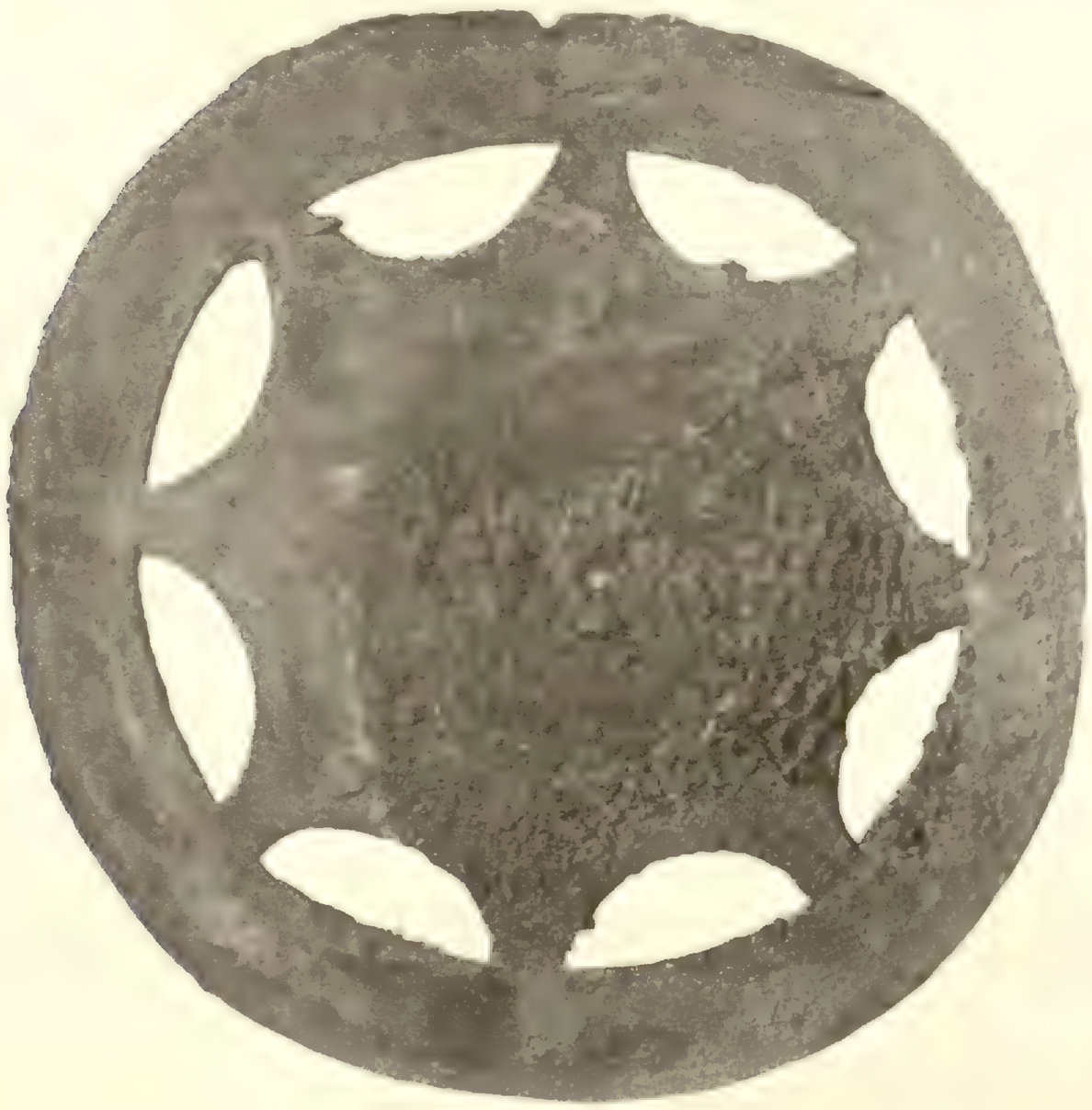


FIG. 43.—Gorget of sheet-copper. Mound C. (Full size.)

FIG. 44.—Hair-ornament of copper. Mound C.
(One-third size.)

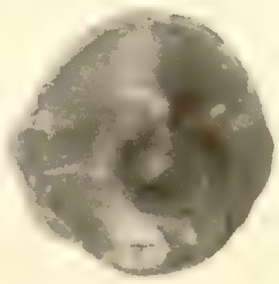


FIG. 46.—Amethyst head.
Mound C. (Full size.)

FIG. 45.—Hair-ornament of sheet-copper.
Mound C. (Full size.)

grooving and notching were apparently done partly with a narrow bit of hard mineral, or by means of sticks, the parties using sand again as an abrasive, which was pushed or rubbed into the spot to be worked upon."

This ends the list of objects found with Burial No. 37, with the exception of a black material in the soil nearby, which was submitted for analysis to Dr. H. F. Keller who writes: "The material you sent me yesterday is a typical specimen of mineral pitch. It gives all the characteristic reactions of asphaltum, and contains 2.65 per cent. of mineral matter."

Asphalt is found in Alabama.[1]

Vessel No. 21, a cup in fragments, since put together, has incised decoration showing the ribbon-fold design (Fig. 48).

But one burial in the mound was found at a depth of 5 feet, although a number were 4.5 feet and 4 feet from the surface. In addition to burials particularly described, eight bunches or aboriginal disturbances were met with, having no artifacts in association. There were present in the mound, away from human remains, fragments of sheet-copper in two places and one bird-arrowpoint of quartz.

With a full-length burial the number of which is not given in our field notes, were two shells (*Tulotoma magnifica*). We are indebted to Dr. H. A. Pilsbry and to Mr. E. G. Vanatta, of the Academy of Natural Sciences, for all determinations of shells given in this report and in the three other reports in this volume.

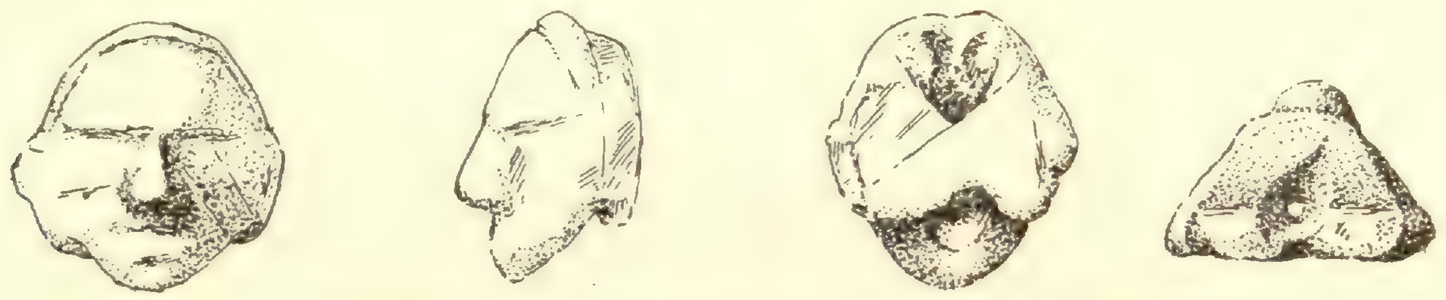


FIG. 47.—Amethyst effigy of head. Four positions. Mound C. (Full size.)

FIG. 48.—Vessel No. 21. Mound C. (Diameter of body 3.8 inches.)

[1] "Asphaltum in 1893." U. S. Geological Survey. Extract from "Mineral Resources of the United States, Calendar Year, 1893." Washington, 1894.

Ground Northeast of Mound C.

Directly northeast of Mound C is a plot of wooded ground having the mound as a base, a deep gully on one side, and the river bluff on the other.

A certain amount of digging was done in this ground, first near the end farthest from the mound, and afterward not far from the base of Mound C, resulting in the discovery of thirty burials of the same general form as those we have minutely described in the account of Mound C.

The artifacts found with these burials seemed to indicate that their former owners had belonged to a class less prosperous than was represented by remains found by us in other places of burial at Moundville. No copper was met with, and in many cases cooking pots of coarse ware were used as burial accompaniments. Where vessels of other forms were found they were undecorated as a rule, and when decoration was present it was often of inferior execution.

Fig. 49.—Vessel No. 1. Ground NE. of Mound C. (Diameter 4.8 inches.)

Fig. 50.—Vessel No. 3. Ground NE. of Mound C. (Diameter 6 inches.)

A skeleton flexed on the right side had mica, and shell beads at each wrist.

The skulls of two infants lay together without the other bones, which, owing to their extremely delicate condition, may have been thrown back unobserved by our diggers. Near these skulls were two small pots, Vessels Nos. 1 and 2, of coarse, unblackened ware, both having loop-handles,—Vessel No. 1 having had nine originally (Fig. 49).

The skeleton of a child, cut off at the pelvis by aboriginal disturbance, had near the head Vessel No. 3,—a pot of coarse, red ware, with two loop-handles (Fig. 50).

A skeleton lying at full length on the back had near the head an undecorated, broad-mouthed water-bottle (Vessel No. 4), and a large fragment of another vessel. Shell beads were at the neck, the left wrist, and at both ankles.

In a pit 4 feet below the surface, was the skeleton of an infant, extended on the back, surrounded by almost pure clay, while the soil at this place had a large

FIG. 51.—Vessel No. 6. Ground NE. of Mound C. (Diameter 7.6 inches.)

FIG. 52.—Vessel No. 9. Ground NE. of Mound C. (Height 8.1 inches.)

admixture of sand. At the head of the skeleton were two large sherds, one on the other, each carefully worked to an elliptical outline.

Vessel No. 5 lay apparently unassociated with human remains and crushed to fragments. After the parts were cemented together the vessel proved to have a broad, short handle projecting horizontally from one side. The decoration, rather coarsely done, is a variety of scroll in a field of cross-hatch.

In a pit, where a number of burials were, lay two vessels (Nos. 6 and 7) near the lower part of a skeleton, the upper part of which doubtless had been cut away in placing a burial at a lower level. Vessel No. 6, a small bowl of inferior. black

FIG. 53.—Vessel No. 9. Ground NE. of Mound C. (Height 6 inches.)

ware with incised decoration of the ribbon-fold design, had a rudely imitated head of an animal looking inward and a conventional tail at the opposite side of the bowl (Fig. 51). Vessel No. 7, a pot of coarse, black ware, had two loop-handles with two small knobs on each. In the general disturbance in this pit these pots presumably had been shifted from a position near the head of a skeleton.

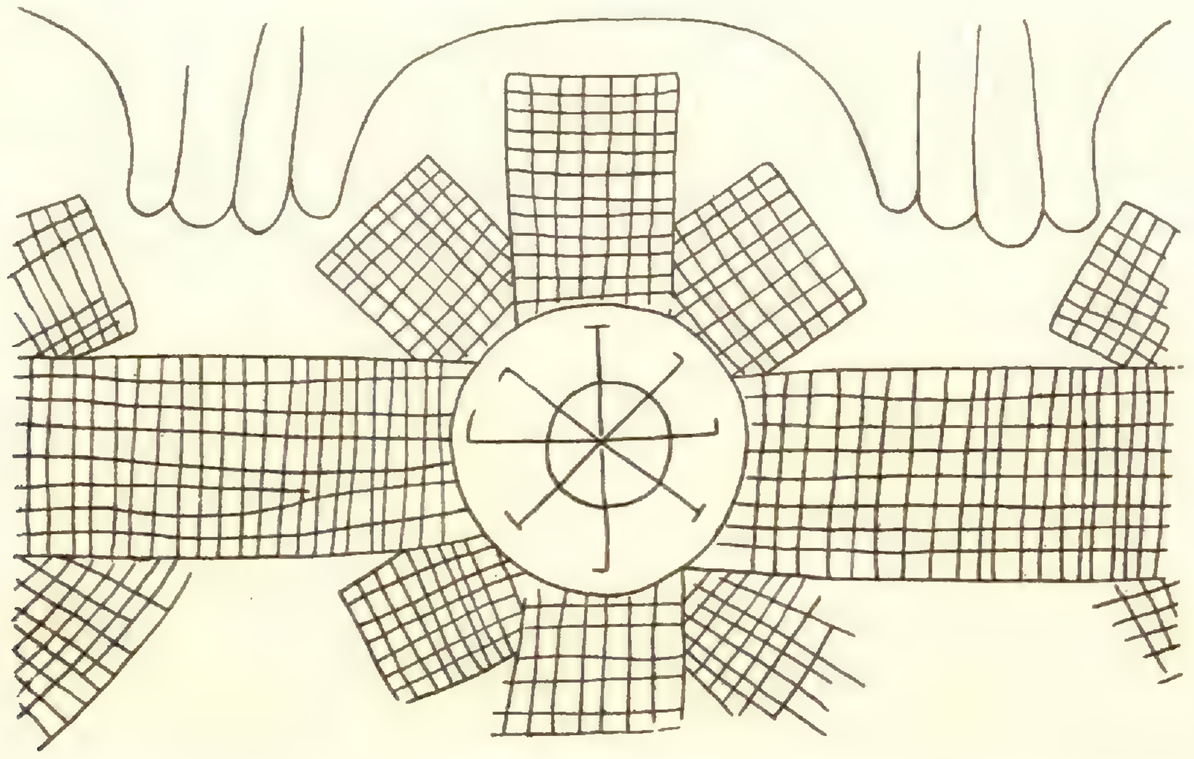


FIG. 54.—Vessel No. 9. Decoration. Ground NE. of Mound C. (About half size.)

Vessel No. 8, badly crushed, lay apart from human remains. Put together, it proved to be a beautiful jar of highly polished ware. The decoration is made up of scrolls, depressions, and incised encircling lines (Fig. 52).

Vessel No. 9 (Fig. 53), with incised design, somewhat similar to others shown before, has, in addition, a representation of fingers projecting downward, as shown in diagram in Fig. 54. The cross and cross-hatch design are shown four times on this vessel, as are the downturned fingers. This vessel lay, unconnected with any burial, in a pit where there had been much aboriginal disturbance.

FIG. 55.—Vessel No. 10. Ground NE. of Mound C. (Diameter 5.75 inches.)

Near the skull of a burial lay a pot, Vessel No. 10, of coarse, red-yellow ware, with four loop-handles (Fig. 55), and Vessel No. 11, a wide-mouthed water-bottle (Fig. 56) bearing on each of two sides an incised design consisting of a central symbol, to which is attached, at each side, the triangular tail of the woodpecker, with its pointed, individual feathers, shown diagrammatically in Fig. 57.

At the heads of two skeletons lying at full length, side by side, was Vessel No. 12, a pot of coarse,

unblackened ware with seven loop-handles, and Vessel No. 13, a small bowl with undecorated body and a rudely imitated animal head looking inward above the rim.

Beneath the skull of an infant lay a large slab of limonite.

FIG. 56.—Vessel No. 11. Ground NE. of Mound C. (Height 7.4 inches.)

FIG. 57.—Vessel No. 11. Decoration. Ground NE. of Mound C. (About half size.)

On the chest of the skeleton of an adult, lying at full length on the back, was a gorget of shell, thickly coated with patina and with a deposit from the surrounding clay and sand. This gorget, bearing a complicated design on one side, after an unsuccessful effort on our part to clean it, was entrusted to experts who, though removing the accumulated material to a certain extent, were unable to make clear the design.

Forty-six inches below the surface lay a skeleton at full length on the back, as usual, having shell beads at the neck, and at the shoulder a slab of sedimentary rock, 9.5 inches by 14 inches by 1.1 inch thick. This slab, carefully dressed on all sides but one, where two deep grooves, front and back, show how it was separated from another portion, has for its only decoration two incised, parallel lines at each end on one side. On this slab are remains of red and of white pigment.

Vessel No. 14, a cooking pot of coarse, yellow-brown ware, lay near several cervical vertebræ in a pit where great aboriginal disturbance had taken place.

Near decaying fragments of a skull was found Vessel No. 15, an undecorated, broad-mouthed water-bottle.

Apart from human remains, singly, were several fragments of "celts;" one small disc of stone; several discs wrought from bits of pottery; slabs of stone; hammer-stones; a circular stone doubly pitted; mica in a number of places; a piercing implement of bone with the articular portion remaining; a part of a smoking-pipe of coarse earthenware, with rough incised lines on two opposite sides. It is worthy of remark how, in northwestern Florida and westward along the Gulf, as well as in the middle Mississippi district as pointed out by Holmes,[1] where pottery vessels are of such excellent ware and of such variety of form and decoration, we find pipes of the same material so inferior in ware and characterized by such uniform want of originality as to shape and ornamentation.

As we shall have occasion to refer to the finding of a number of pipes at Moundville, we may say here that we fully share Professor Holmes' belief[2] "that the pipe was in use in America on the arrival of Europeans," and the more the mounds are investigated, the more forcibly is this belief corroborated.

Mound D.

Mound D, with a summit plateau measuring approximately 60 feet by 90 feet, yielded to our trial-holes dark, disturbed soil and burials in the middle half of the eastern side and in the northern part of the western side. Therefore, we deemed it advisable to dig out the northern part of the plateau, to the depth of from 3 to 4 feet, where the loamy soil ended and more solid clay began. The area dug through by us and the parts in which burials proved to be are shown in the plan (Fig. 58). Ten trial-holes were sunk into the southern half of the mound without material result.

There were present in the soil, apart from human remains (though bones with

[1] "Aboriginal Pottery of Eastern United States," 20th An. Rep. Bur. Am. Eth., p. 83.
[2] *Op. cit.*, p. 45.

which they may have been perhaps had decayed away or may have been disturbed by other burials), the following: A small amount of sheet-copper of about the consistency of moistened bread-crust; other bits of sheet-copper; a small amount of sheet-copper in another place; a pipe of very coarse earthenware, rudely made, round in horizontal section, with flaring rim (Fig. 59); two roughly made discoidal stones and one more neatly rounded; one disc of pottery; a small, roughly made

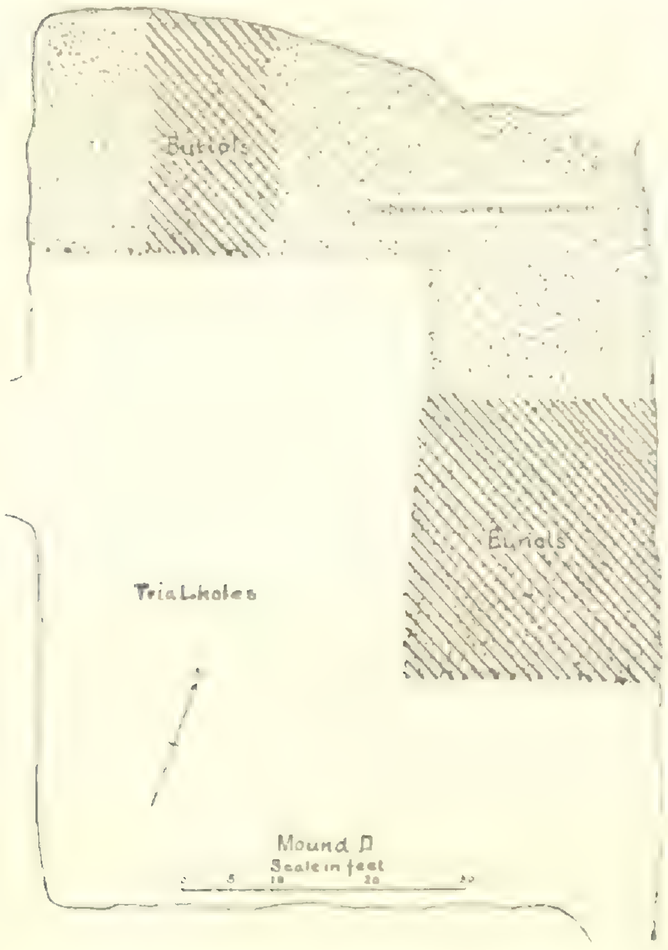


FIG. 58.—Plan of excavation. Mound D.

FIG. 59.—Pipe of earthenware. Mound D. (Full size.)

"celt"; a "celt" of greenstone or kindred rock, with cutting edge at either end, and beveled (Fig. 60); a slab of ferruginous sedimentary rock, oval in outline; and a barrel-shaped bead, probably of resin, 1.75 inches in length. Doctor Keller, who analyzed part of this bead, found it to be "a resin which, though in some respects resembling amber, is not fossilized. The interior is perfectly clear and almost colorless. The specific gravity is 1.091; it softens at about 150° C., but does not melt until heated to above 300°. It is strongly electrified by friction. Unlike amber, it is largely soluble in alcohol and other solvents. On burning it leaves very little ash, containing oxide of iron."

In addition to the usual dwelling-site debris, hones, hammers, pitted stones, etc., there were present: a small quantity of rather coarse, shell-tempered ware in fragments, one sherd having projecting from its rim the head of a frog, rudely represented; three pointed implements of bone and one less pointed, perhaps used in basketry; and a bone, kindly identified by Prof. F. A. Lucas, as having belonged to a swan.

Eighteen inches from the surface, with no human bones remaining nearby, completely inclosed in decayed wood, was a ceremonial axe of copper, 14.25 inches in length, with flaring cutting edge 1.5 inches broad, varying in breadth between .5 inch and 1 inch, with a maximum thickness of .4 inch where there is a kind of offset made by the hammering of the copper. Part of a wooden handle still adheres to the metal (Fig. 61).

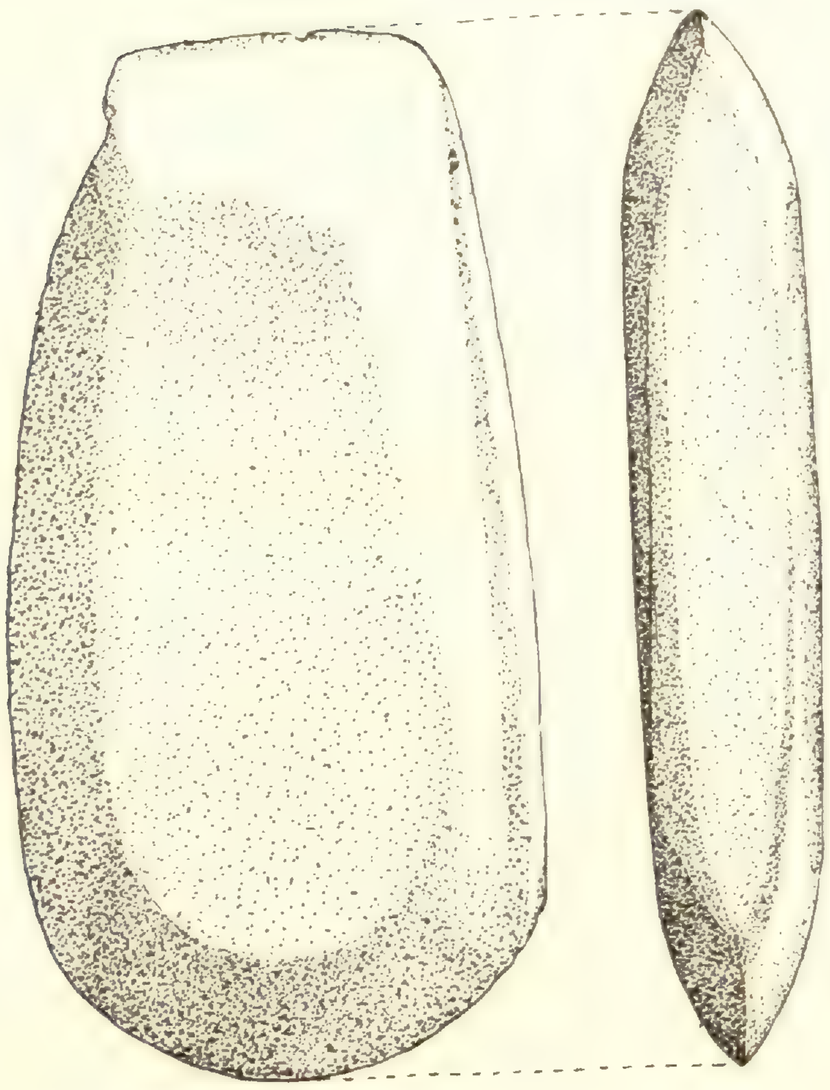


FIG. 60.—"Celt." Mound D. (Full size.)

FIG. 61.—Ceremonial axe of copper. Mound D. (Length 14.25 inches.)

FIG. 62.—Vessel No. 4. Mound D. (Diameter 4.75 inches.)

With the skeleton of a child, cut off below the pelvis, doubtless an aboriginal disturbance, was a mussel-shell (*Lampsilis rectus*), much worn at one end as if by use.

From 2 to 3 feet below the surface, covering a considerable area, was a deposit of bones, including eleven skulls. With this deposit, at its southern margin, were Vessels Nos. 1 and 2,—a small, undecorated water-bottle of coarse material, and a small bowl with rude, incised-line decoration below the rim, having an upright head, seemingly that of a dog, looking inward. Farther along in this deposit were three vessels (Nos. 10, 11 and 12), which will be described in their proper order.

With a burial represented by crowns of teeth alone was an ornament of badly corroded sheet-copper, and a water-bottle (Vessel No. 3), with incised decoration consisting of the open hand with the open eye upon it, six times repeated. The neck of this bottle was not recovered.

In a pit was a skeleton at full length on its back, having shell beads near the head and at one wrist. Crushed to fragments, near this skull, was Vessel No. 4, a bowl of black ware that has since been put together (Fig. 62), having upon it an engraved design representing three human skulls, one inverted, with three human hands alternating with them, two pointing downward, one upward. On each hand is the open eye (Fig. 63). An especially curious feature in respect to the skulls is that the articular part of the lower jaw, or possibly the whole ramus, is represented as projecting beyond the base of the skull. Later in this report we shall have something farther to say on this point.

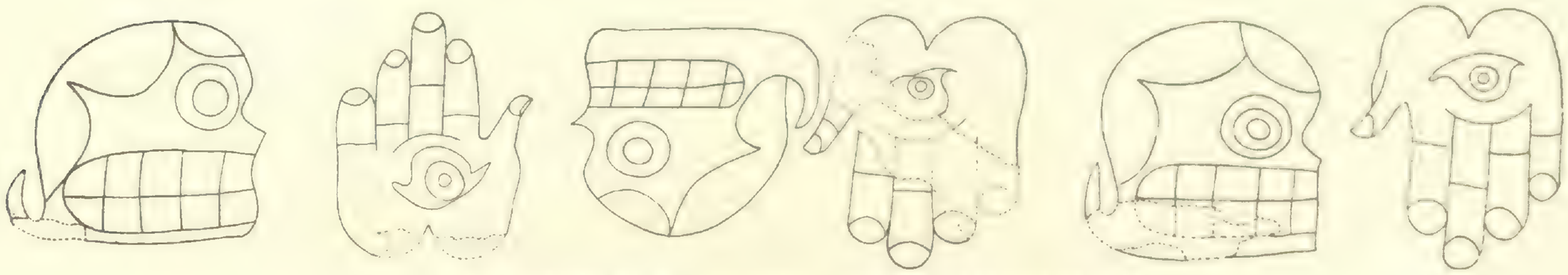


FIG. 63.—Vessel No. 4. Decoration. Mound D. (About half size.)

In the same pit was another skeleton lying at full length, face downward, having a sheet-copper ear-plug and shell beads near the skull. On a clavicle was the lower part of what was probably a sheet-copper pendant with a *repoussé* eye upon it, somewhat similar to those found in Mound H at Moundville.

About three feet from the surface was a skeleton at full length on the back, having at the legs Vessel No. 5, crushed flat. This vessel, pieced together (Fig. 64), shows an incised decoration consisting of fingers and conventionalized bodies with a tail of a bird projecting from each side. In the soil about 6 inches above the pelvis of the same skeleton was a disc of metamorphic gneiss, 10.25 inches in diameter, in an upright position, having a scalloped margin and two concentric circles incised below it on one side (Fig. 65). The customary paint was present. The position of this disc seemed to indicate that it had been thrown back after an

aboriginal disturbance and, presumably, the vessel found near the legs of the skeleton had been thrown there at the same time. At the head of the same skeleton was Vessel No. 6, crushed flat into bits, and Vessel No. 7, an undecorated bowl with inverted rim, badly broken, and containing another bowl (Vessel No. 8) with scalloped projections around the margin.

Vessel No. 6, since repaired and the missing parts restored, has for decoration, on two opposite sides, the woodpecker, with two heads, one pointing upward, the other downward, and a tail projecting from the common body at each side. No speech symbols are represented as leaving the open bill, nor is the tongue extended.

Three skeletons lay radiating from a common center represented by the skulls. Two of these skeletons lay at full length on the back; the other had the upper part of the trunk lying on the back, but was turned on the left side from the pelvis downward. The left humerus of the last skeleton showed a former break with considerable bending of the bone and development of new tissue. This specimen was sent to the Army Medical Museum at Washington.

FIG. 64.—Vessel No. 5. Mound D. (Height 5.5 inches.)

With part of a skeleton, including bones from the dorsal vertebræ downward, was Vessel No. 9, a small, undecorated pot of very coarse ware, with two loop-handles.

A skeleton at full length on the back had three shell beads of medium size at one ankle.

A rough, discoidal stone lay near the skeleton of a child, extended on the back.

The skeleton of an adolescent, in a similar position, had with it a number of fresh-water shells of the following kinds: *Obovaria circulus*, *Quadrula ebena*, *Q. stapes*, *Q. pernodosa*, *Unio congaræus*, *Obliquaria reflexa*, *Truncilla penita*.

Near the farther extremity of the large deposit of bones of which we have spoken were Vessel No. 10, a small, undecorated, wide-mouthed water-bottle;

FIG. 65.—Stone disc. Mound D. (Diameter 10.25 inches.)

Vessel No. 11, a small, undecorated bowl; and Vessel No. 12, a water-bottle, also small and undecorated.

In addition to the burials already described, there were in the mound, without artifacts:

Skeletons full length on back, one of an adolescent—8.
Skeleton at full length, face down—1.
Scattered deposits of bones—2.
Aboriginal disturbances—5.
Infant skeletons, badly decayed, two side by side—4.

There were also instances where bones had been widely scattered in pits over burials. In one case the bones of a child were mingled with the soil that filled a pit, on the bottom of which lay a skeleton.

Field North of Mound D.

A short distance north of Mound D is a cultivated field, about two acres in extent, having rising ground, artificially made, on the northern and southern extremities, and dark soil such as is found in dwelling sites. We were guided to this field (marked W on the survey) by a colored man who sold to us a disc of metamorphic gneiss, 7.25 inches in diameter (Fig. 66), which he said he had ploughed up at that place.

Two days were devoted by us to this field, with a digging force averaging sixteen men. In the southern part of the field alone were artifacts discovered, with the exception of one shell bead.

Burials ranged in depth from superficial to 4.5 feet. Those near the surface lay in the dark soil that covered the field, made up of sand, clay, and the remains of organic matter. The deeper burials were in pits extending into yellow sand in places, into yellow clay in others, which underlay the artificial soil that had accumulated during and since the use of the field as an aboriginal place of abode. Other pits present in the field, including one 6 feet deep, contained no human remains.

In the southern end of the field were:

Bunched burials—2.
Skeletons flexed on the right side—3.
Skeletons flexed on the left side—3.
Skeleton closely flexed on the left side—1.
Skeletons at full length on the back—15.
Skeleton of an infant, badly decayed—1.
Skeleton of a child, badly decayed—1.

In addition, there were recent disturbances rising from cultivation of the soil, aboriginal disturbances, and many scattered bones whose form of burial we were unable to classify.

On the surface and in the dark soil of the dwelling site were many pebbles; pebble-hammers; sandstone hones; pitted stones, triangular as a rule; and fragments of coarse earthenware, many having loop-handles. There were present, also,

drills; discs made from earthenware vessels; several bird-arrowheads of jasper and one of quartz; three rough arrowheads or knives, one of chert; and a long, slender arrowhead of jasper.

Near certain loose bones were a mass of limonite and an implement of bone decorated with notches and incised lines.

FIG. 66.—Stone disc. Field north of Mound D. (Diameter 7.25 inches.)

One of the bunched burials referred to was in reality a deposit of bones extending over a number of square feet. Near a skull in this mass of bones were two carefully made lanceheads of quartzite, one 6.25 inches, the other 8 inches, in length. With these were masses of limonite and of hematite, a small jasper arrowhead, and a thin slab of ferruginous sandstone. At another part of this deposit of bones were two lanceheads of quartzite, 7 inches and 7.5 inches in length, respectively, having notches at the base for attachment, which the other two lanceheads

did not have. With the lanceheads found last was a number of beads made by grinding down small shells (*Anculosa talniata* and *Lithasia showalterii*).

The badly decayed skeleton of a child had shell beads at the wrists and at the knees.

Another skeleton had, near the lower part of the trunk, shell ornaments, very badly decayed, made from small sections of conch, pierced at one end. At the right shoulder, where the wrist of one hand had rested, were shell beads.

With several burials were small quantities of mica.

Vessel No. 1.—A shallow basin of coarse, shell-tempered ware, undecorated save for notches around the margin (Fig. 67). This vessel lay alone near the surface, the skeleton to which it belonged presumably having been ploughed away.

Vessels Nos. 2 and 3.—A skeleton lying at full length on the back, had on the

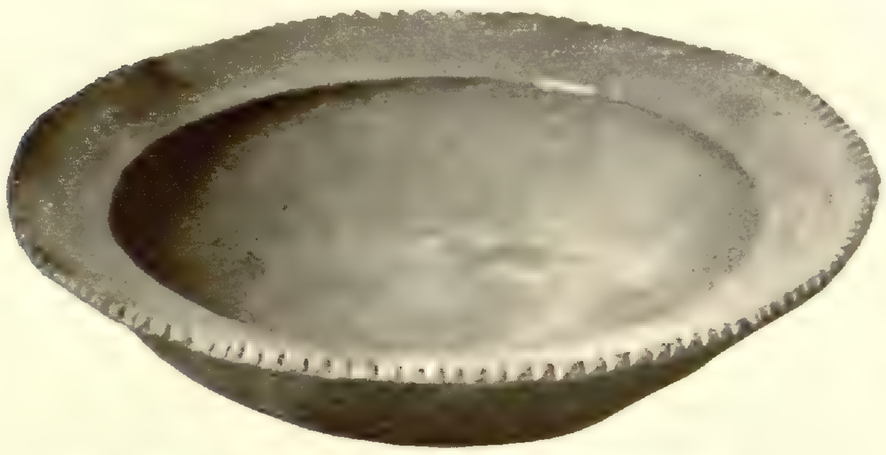


FIG. 67.—Vessel No. 1. Field north of Mound D. (Diameter 9.5 inches.)

FIG. 68.—Vessel No. 3. Field north of Mound D. (Height 4 inches.)

upper part of the thorax a fragment of coarse earthenware, 6 inches by 8 inches, approximately. The skull was somewhat elevated. Some inches below it was a fragment of pottery of about the same size as the other, and beneath it Vessel No. 2, a small bowl with notches around the margin. By the side of this bowl, but not covered by the pottery fragment, was a small, undecorated water-bottle, Vessel No. 3 (Fig. 68).

Vessel No. 4.—Two feet from a skeleton and somewhat below it, standing upright on the floor of a shallow pit, was a wide-mouthed water-bottle of black ware, having around the body a decoration of depressions and incised lines forming a scroll, a popular pattern at Moundville.

Vessel No. 5.—An undecorated water-bottle of coarse, red ware, found lying at the head of a skeleton. Under the skull was a slab of a derivative of trap-rock, irregularly oblong, 4 inches in length by 3 inches broad. At the feet were fragments of sheet-copper and two small, neatly-made discoidal stones. A femur from this skeleton, showing pathological condition, was sent to the Army Medical Museum at Washington.

FIG. 69.—Vessel No. 6. Field north of Mound D. (Diameter 8.3 inches.)

Vessel No. 6.—This vessel (Fig. 69), found lying by the skull of a skeleton, presumably represents a frog.

Vessels Nos. 7, 8, 9, 10.—Twenty-two inches from the surface was a skeleton extended on the back. Immediately at the left of the skull, which had a fragment of pottery beneath it, was Vessel No. 10, and two others (Vessels Nos. 8 and 9), were just beyond it. All these were of inferior ware, and each had two loop-handles below the rim and two small projections equidistant therefrom. Within Vessel No. 9 was a pot of coarse ware, in fragments. The photograph of this skeleton, reproduced in Fig. 70, unfortunately could not be taken in a position to show all the vessels.

FIG. 70.—Skeleton with certain accompanying vessels. Field north of Mound D.

Vessel No. 11.—This vessel, a wide-mouthed water-bottle (Fig. 71), with incised scroll design surrounding depressions, had been placed beside the skull of an extended skeleton. Beneath this vessel, but not in contact with it, was a fragment of a pot.

Vessel No. 12.—An interesting water-bottle, with handles, as shown in Fig. 72. Near this vessel was a large fragment of pottery.

FIG. 71.—Vessel No. 11. Field north of Mound D. (Height 5.8 inches.)

Vessels Nos. 13 and 14.—Vessel No. 13, a small bowl with incised decoration of the ribbon-fold pattern (Fig. 73), and Vessel No. 14 (Fig. 74), a wide-mouthed water-bottle with four incised designs, all similar (two of which are shown), lay near the remains of the skull of an infant or of an older child, from which the remainder of the skeleton, in all probability, had crumbled away.

Vessels Nos. 15 and 16.—Vessel No. 15, a small, undecorated bowl, and Vessel No. 16, a broad-mouthed water-bottle bearing a decoration consisting of the characteristic depressions surrounded by incised scrolls, lay together beside the skull of a skeleton at full length.

Vessel No. 17.—A bowl badly broken, but since put together (Fig. 75), having as decoration incised scrolls partly interlocked, lay by the shoulder of an extended skeleton.

Vessel No. 18.—This vessel, found in fragments just below the surface, has upright bands with cross-hatch decoration.

Vessel No. 19.—Into a pit, probably roughly circular, 4 feet deep and 3 feet in diameter, another pit had been dug. This second pit, 28 inches deep and 30 inches in diameter, extended 6 inches beyond the margin of the lower pit on one side. At the bottom of the upper pit was a skull, several cervical vertebræ, and one clavicle. With the clavicle were decaying fragments of a sheet-copper ornament and certain shell beads. Considerably above these bones was a bunch of parallel long-bones made up of what remained of two humeri, two femurs, two tibiæ, one patella, and one ulna. Near the skull of the lower deposit was a small, broad-mouthed water-bottle (Vessel No. 19*a*), having two holes for suspension.

Vessel No. 20.—Part of a vessel of eccentric shape, having a portion of the rim much lower than the remainder which has been scalloped. The base is flat (Fig. 76). This vessel belongs to an unfamiliar type of which more will be said in connection with Vessel No. 37, Mound O.

FIG. 72.—Vessel No. 12. Field north of Mound D. (Height 8.6 inches.)

FIG. 75.—Vessel No. 17. Field north of Mound D. (Diameter 4.4 inches.)

FIG. 73.—Vessel No. 13. Field north of Mound D. (Height 4.7 inches.)

FIG. 74.—Vessel No. 14. Field north of Mound D. (Diameter 4.4 inches.)

The head of a duck (Fig. 77), an ornament belonging to an earthenware vessel, lay alone in the soil.

FIG. 76.—Vessel No. 20. Field north of Mound D.
(Height 3.4 inches.)

FIG. 77.—Duck's head of earthenware. Field north of Mound D.
(Full size.)

GROUND SOUTH OF MOUND D.

Between the cultivated field that borders Mound B on the east and the southern side of Mound D is a strip of land covered with small trees, and having a deep gully on two sides. This strip, running very nearly north and south, is about 500 feet long and varies from 75 to 140 feet in width. Nineteen trial-holes, considerably larger than those sunk by us in summit plateaus of mounds, were dug in the eastern, or higher part of this strip. These holes were about 3 feet deep except where pits were encountered, in which event they were correspondingly enlarged and deepened.

Twenty-five burials, including two skeletons together, were met with. These were similar in form to other burials found at Moundville.

All earthenware found with the dead came from two pits.

At the head of a skeleton, 20 inches down, was Vessel No. 1, a small, undecorated, wide-mouthed water-bottle; and Vessel No. 2, a handsome pot of polished, black ware, with two loop-handles, made in the effigy of a frog (Fig. 78). Elsewhere in this cemetery various fragments were met with which indicated that the concept of the frog had been a popular one during the time the burial place was in use. With the same skeleton was a small "celt" with one side smooth and the other rough, except at the cutting edge.

Vessel No. 3.—A little toy bowl, representing a tortoise, having the head and one flipper missing (Fig. 79), lay near the surface apart from human remains.

FIG. 78.—Vessel No. 2. Ground south of Mound D. (Diameter 6.75 inches.)

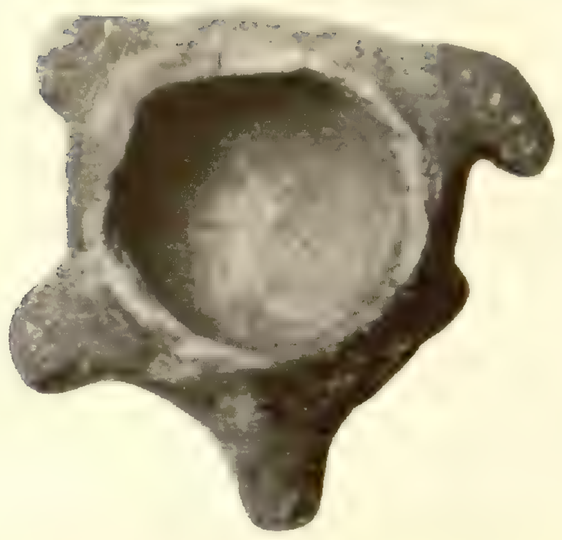


FIG. 79.—Vessel No. 3. Ground south of Mound D. (Full size.)

In the same pit as the frog effigy-vessel were a skull and certain disturbed bones. Near the skull were Vessel No. 4 (Fig. 80), a small, wide-mouthed water-bottle having the popular decoration consisting of incised scrolls surrounding depressions in the body of the vessel, and fragments of another vessel that had been broken by an aboriginal disturbance.

Still in the same pit were the skull and upper part of a skeleton, the remainder having been cut away to make room for another burial. Near the skull was Vessel No. 5, a pot of coarse, red ware, the shell-tempering showing all over it, with two loop-handles, and having below the margin a circle of projecting knobs. With this pot was Vessel No. 6, a wide-mouthed water-bottle with globular body and rounded base, an exception to the style that prevailed at Moundville, where the bases were usually flat. On part of the body of the vessel is a faintly outlined pattern where decoration has been started and abandoned (Fig. 81).

An extended skeleton lying on its back had over the face a portion of a large

FIG. 80.—Vessel No. 4. Ground south of Mound D.
(Diameter 4.4 inches.)

FIG. 81.—Vessel No. 6. Ground south of Mound D.
(Diameter 6.6 inches.)

bowl, inverted. The neck was not covered, but over the chest and abdomen to the pelvis had been placed a layer of sherds.

In another pit was a full-length skeleton on its back, having near the left side of the skull Vessel No. 7, a small, undecorated bowl, in fragments. At the right shoulder were two smoking-pipes of inferior ware (Figs. 82, 83). Near the right humerus was Vessel No. 8, a small, undecorated bowl, broken into two parts. With the bowl was Vessel No. 9 (Fig. 84), in fragments, a wide-mouthed water-bottle bearing on each of two opposite sides a design of a bird with two heads, one pointing

FIG. 82.—Pipe of earthenware. Ground south of Mound D.
(Full size.)

FIG. 83.—Pipe of earthenware. Ground south of Mound D.
(Full size.)

FIG. 84.—Vessel No. 9. Ground south of Mound D. (Height 5.2 inches.)

upward, one downward, and a circular symbol, perhaps denoting the body in common. At each side of this body is a triangular tail with pointed, individual feathers (Fig. 85). The bird, presumably, is intended to represent the heron, which still frequents the Black Warrior near the Moundville mounds. To this heron, or these herons, however, have been given tails of the woodpecker, which were a popular device in Moundville pottery decoration. Aboriginal artists were not always consistent. Another inconsistency, if the heads are intended for those of herons, is the extended tongue, this bird not using its tongue in the manner common to woodpeckers.

In the same pit, at the head of a skeleton flexed on the right side, was a broad-mouthed water-bottle, Vessel No. 10 (Fig. 86), with scroll, finger, and cross-hatch decoration; and an undecorated bowl, Vessel No. 11, with notched margin.

With the skeleton of an infant were two canine teeth of large carnivores, each perforated for suspension.

Apart from human remains was a fragment, 5 inches in length including the point, of what had been a sword or dagger, of chert.

Several discs cut from sherds of earthenware vessels were found singly.

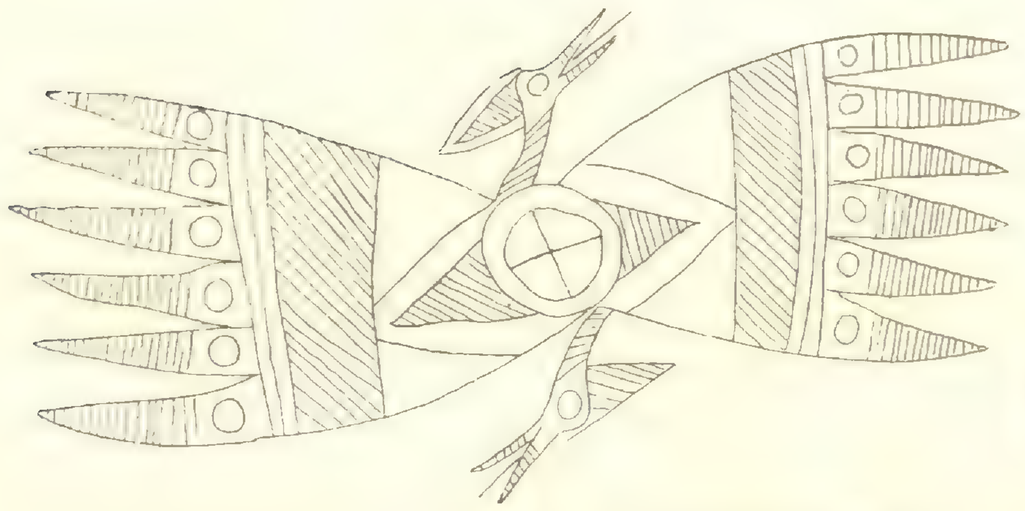


FIG. 85.—Vessel No. 9. Decoration. Ground south of Mound D. (About half size.)

FIG. 86.—Vessel No. 10. Ground south of Mound D. (Diameter 5.9 inches.)

MOUND E.

Mound E, about square as to its summit plateau, each side being about 140 feet in length, has undergone much cultivation, and there is much slant to the northwestern part of the plateau where heavy and repeated wash of rain has eaten deeply into the mound. Thirty-three trial-holes yielded no indication of burials.

MOUND F.

Mound F, seamed with gullies on every side, evidently has lost a considerable part of its summit plateau through wash of rain, after cultivation. The part of the plateau remaining is about 40 feet east and west by 70 feet north and south.

Eleven trial-holes showed the presence of burials in the northeastern part of the mound. Considerable trenching was next undertaken, extending the full length of the mound on each side. One of these trenches showed additional burials in the same part of the plateau.

Eventually a space 38 feet long by 28 feet wide, was marked out on the northern part of the plateau, and well to the eastward, excluding northern and western portions of the plateau where no indication of burial had been found. The area thus selected was completely dug through to a depth of 4 feet, and deeper when necessary in following pits.

Burials proved to be confined to a limited area along the eastern side of the plateau, in the northern part. Presumably the burial area had been greater, but had washed away with parts of the northeastern limit of the mound. The burials, nineteen in number, were very fragmentary, being in the last stage of decay, and often represented merely by a few crumbling bits.

Vessel No. 1 is a small, broad-mouthed water-bottle, undecorated, found in fragments.

Vessel No. 2, a small bowl with rough, incised decoration, lay with a disc, 6

inches in diameter, made from a portion of a pottery vessel. No bones were with these objects, though presumably they had been present.

Apart from human remains was a discoidal stone about an inch in diameter, probably of tufa, of a type of which we found a number at Moundville, and elsewhere, namely, with the base somewhat larger than the upper surface, giving the stone the appearance of a much truncated cone. Somewhat later a discoidal of amphibolite was met with, of the same type but a trifle larger. This stone had in

FIG. 87.—Vessel No. 3. Mound F. (Height 6.2 inches.)

the middle of each of its flat surfaces a hole drilled so deeply that the two nearly met. The day succeeding the finding of this stone, while digging trial-holes in a field immediately north of Mound H, we came upon a beautiful discoidal stone having, at first glance, the appearance of hematite, but being in reality limonite that had undergone change to hematite on the surface only. This discoidal, 1.5 inch in diameter, was drilled completely through. With the discoidal stone found in Mound F was a carefully rounded disc of pottery, seemingly made from a frag-

ment of a vessel, having five small perforations forming an irregular circle somewhat below the margin.

Vessel No. 3, a broad-mouthed water-bottle, lay in small fragments near the skull of an extended skeleton. The vessel, pieced together (Fig. 87), bears a series of curious symbols. The rosette figures represent the sun, according to Professor Holmes.[1] We have also, according to Professor Putnam, an arrow and the sun, possibly a winged sun. This symbol bears some resemblance to the *ollin* of the Mexicans. It would be quite in keeping to represent an arrow with the sun, the arrow representing a ray or dart of the Sun-god, and the sun representing his shield as portrayed by our Indians down to the present time.[2] The group of symbols on this vessel is shown in diagram in Fig. 88.

Vessel No. 4, a wide-mouthed water-bottle, lay apart from human remains.

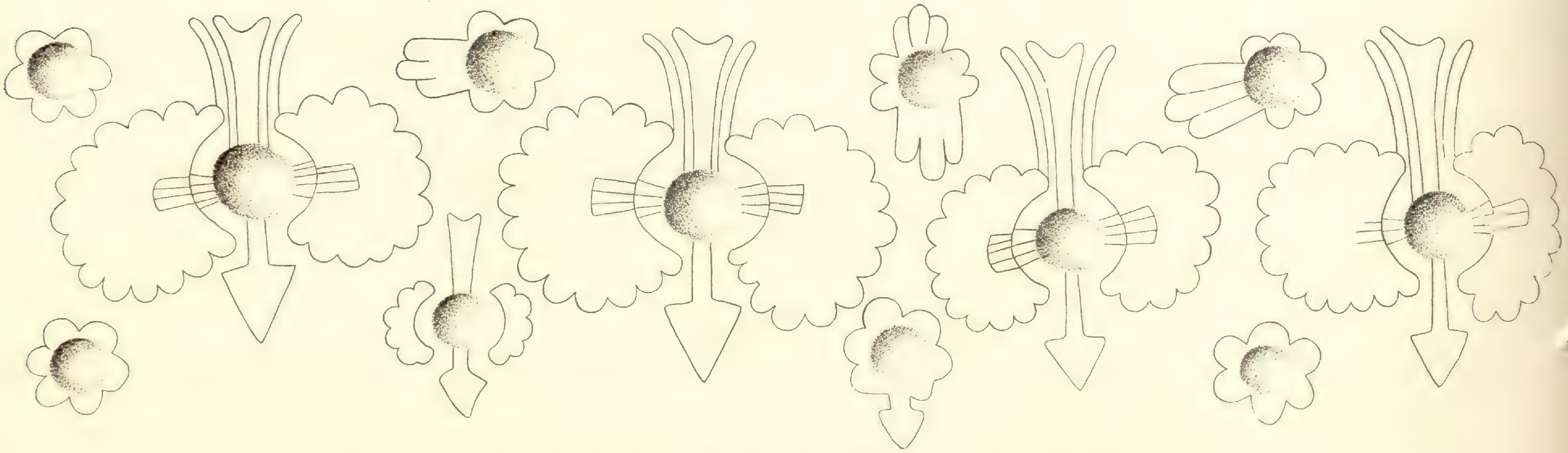


FIG. 88.—Vessel No. 3. Decoration. Mound F. (About half size.)

Pieced together (Fig. 89), the vessel shows four triangular tails of the woodpecker with their individual, pointed feathers, two tails pointing upward and two downward. On each tail is a swastika (Fig. 90), incomplete in two instances.

Lying apart from where burials were, was a grotesque figurine of earthenware (Fig. 91), evidently a toy, with the legs broken off at the junction with the body. There is a hump on the back. Two projections on the head probably represent copper hair-ornaments; two similar projections have been broken off.

Vessel No. 5, a small, undecorated pot with flaring rim and two loop-shaped handles, lay near fragments of a skull.

[1] *Op. cit.*, p. 91.

[2] "He took from pegs where they hung around the room and gave to each * * * a chain-lightning arrow, a sheet-lightning arrow, a sunbeam arrow, a rainbow arrow," * * *. "Navaho Legends," Washington Matthews, Memoirs of the Am. Folklore Soc., Vol. V, p. 111.

"For the orb of day is to the Navaho, only the luminous shield of the god, behind which the bearer walks or rides, invisible to those on earth." "The Night Chant, a Navaho Ceremony," Washington Matthews, Memoirs Am. Mus. Nat. Hist., N. Y., Vol. VI, p. 30.

FIG. 89.—Vessel No. 4. Mound F. (Diameter 6.5 inches.)

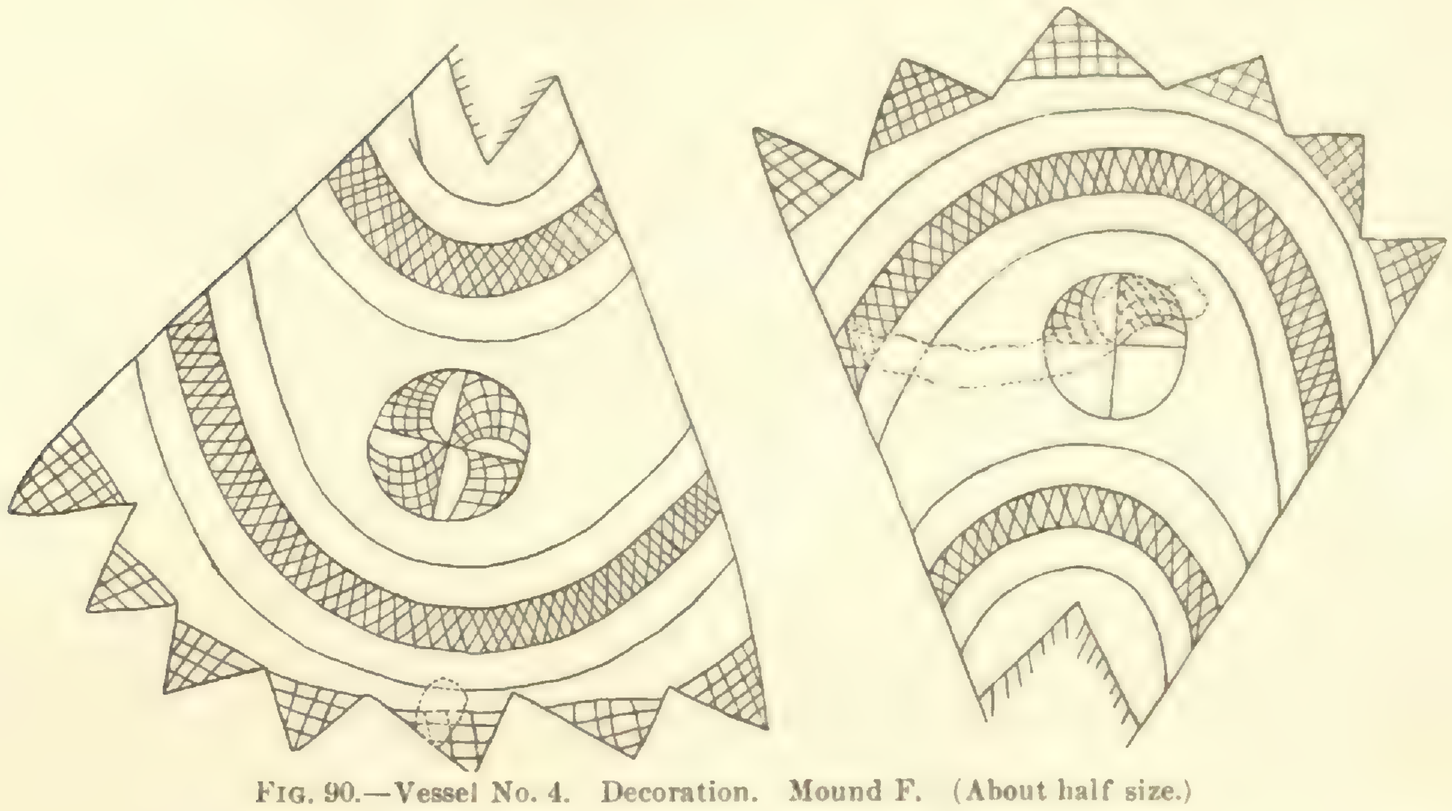


FIG. 90.—Vessel No. 4. Decoration. Mound F. (About half size.)

Vessel No. 6, a shallow bowl with scalloped margin and rudely incised interior decoration (Fig. 92), was found near what remained of a cranium.

At the head of a skeleton extended, was Vessel No. 7, crushed to fragments,

an undecorated, broad-mouthed water-bottle of the coarsest ware of any vessel of that class found by us at Moundville.

In caved soil was Vessel No. 8, a small, undecorated bowl of very inferior ware.

At the right elbow of an extended skeleton was Vessel No. 9, a pot of coarse ware with loop-handles.

FIG. 91.—Part of figurine. Mound F. (About full size.)

FIG. 92.—Vessel No. 6. Mound F. (Diameter 8 inches.)

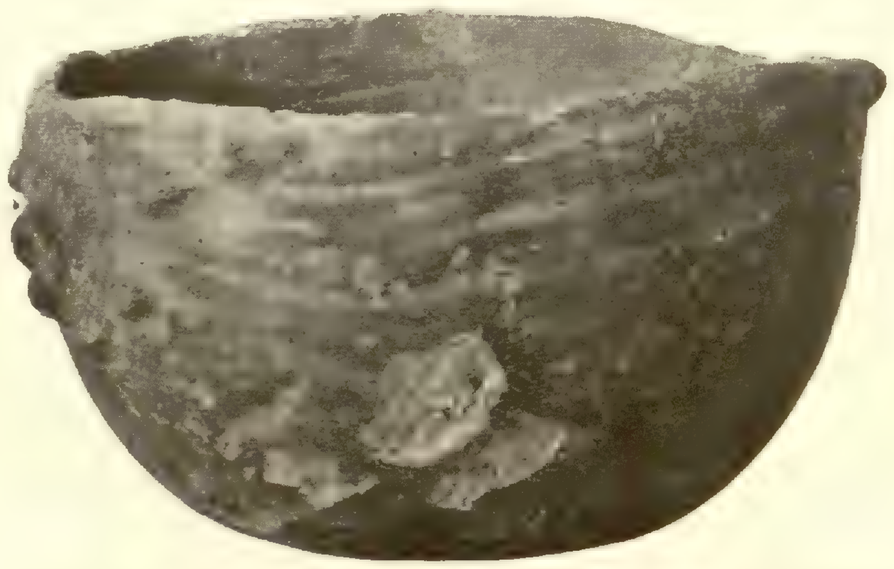


FIG. 94.—Vessel No. 12. Mound F. (Diameter 5.75 inches.)

FIG. 93.—Vessel No. 10. Mound F. (Height 6.3 inches.)

FIG. 95.—Pipe of soapstone. Mound F. (Full size.)

FIG. 96.—Vessel No. 13. Mound F. (Height 5.2 inches.)

FIG. 98.—Vessel No. 15. Mound F. (Height 4.3 inches.)

FIG. 97.—Vessel No. 14. Mound F. (Height 7 inches.)

FIG. 99.—Earthenware effigy of owl. Mound F. (Full size.)

Vessel No. 10, not identified with any burial, is a broad-mouthed water-bottle, badly broken. On each of two sides of the body of the bottle is a rude attempt to delineate the human head, now partly weathered away (Fig. 93).

Near the skull of a full-length burial was Vessel No. 11, a pot of coarse, brown ware, broken to bits; and Vessel No. 12, a bowl, somewhat crushed, with a number of small knobs in a group on one side, near the rim (Fig. 94),—perhaps a conventional shell form. We found a number of fragments of similar vessels at Moundville.

Burial No. 17, so decayed that only with difficulty could the bones be identified

as belonging to an extended skeleton, had near what was left of the skull, a beautiful pipe of soapstone, blackened and highly polished (Fig. 95). From the general appearance of this pipe and from its decoration of projecting knobs one would not refer it to the Moundville region, but consider it rather a Georgia form, though in that State similar pipes are of earthenware. C. C. Jones figures one from a mound near Macon, and we obtained one on the Georgia coast and another in a mound on the bank of the Savannah river. With the burial with which the pipe was, was Vessel No. 13, a small, undecorated, broad-mouthed water-bottle (Fig. 96).

At the head of a skeleton was Vessel No. 14, a broad-mouthed water-bottle of a well-known southern type (Fig. 97). At the knees of the same skeleton was a small, broad-mouthed water-bottle, badly broken.

A full-length skeleton had a small, undecorated water-bottle (Vessel No. 15) at the head (Fig. 98).

Apart from human remains was a curious little effigy of an owl, rather rudely made, standing on four legs (Fig. 99).

Mound G.

Mound G, the sides of which have been much washed by rain, has a summit plateau that measures about 65 feet by 80 feet. There are no signs of previous cultivation of the plateau, but an unimportant trench has been carried in from the eastern side, partly across the plateau. Twenty-five trial-holes gave no indication of pit, of burial, or of artifact.

Mound H.

Mound H, evidently a much smaller mound, originally, than its companions, has been ploughed away and dug through to such an extent that it is no longer possible to conclude as to its former height or shape. The height of the mound given in our list is perhaps misleading, including as it does a mass of flattened debris thrown out by former diggers. A small part, which had escaped former excavators, proved of considerable interest.

Fig. 100.—Vessel No. 3. Mound H. (Diameter 5.5 inches.)

Fig. 101.—Shell beads. Mound H. (Full size.)

Vessels Nos. 1 and 2, a water-bottle and a bowl, respectively, both of coarse ware, and each with rude, incised decoration, were found apart from human remains, which, probably, had been dug away. The water-bottle, which stood upright, had on its neck the bowl inverted.

Vessel No. 3, an undecorated water-bottle, found somewhat broken, has since been pieced together (Fig. 100).

Burial No. 1, an adult lying at full length, had fourteen shell beads, each .75 inch in diameter, at the ankles, and eight of about the same size at the right wrist. On the chest were 407 spool-shaped shell beads, neatly made, ranging between .4 and .6 of an inch in length (Fig. 101), and also a number badly broken. At the right shoulder and arm were 266 tubular beads of shell, ranging from 1 inch to 1.75 inch in length. With these beads were three of the kind found at the ankles, and several bits of shell, the use of which was not apparent. Under the

FIG. 102.—Gorget of copper. Mound H. (Full size.)

chin were fragments of a sheet-copper gorget which, partly pieced together, is seen to have been a six-pointed star enclosed within a circle and having a *repoussé* eye in the center (Fig. 102). With this gorget was a number of small, perforated pearls used as beads. Near the head, where the hair had been, was an ornament of sheet-copper that fell into small fragments on removal. On the other side of the head was a button-shaped object of wood, perhaps an ear-plug, about .75 inch in diameter, with an encircling groove, and copper-coated on the upper, or convex side.

Apart from human remains, and alone, was a small, circular ornament of sheet-copper, with a beaded margin and a central concavo-convex boss. A broken jasper arrowhead also lay alone.

Burial No. 2, the skeleton of a powerfully built, but not especially tall, adult male. At the right foot was a disc of fine-grained gneiss, 7.5 inches in diameter, with incised scallops around the margin and three encircling, parallel lines below (Fig. 103). On this disc was a considerable amount of red pigment. At the ankles of the skeleton were sixteen beads of shell, 1 inch and 1.25 inch in their minor and major axes. At each knee were many spool-shaped shell beads. At the right margin of the pelvis was a copper ceremonial hatchet (Fig. 28E), 5.75 inches in length

FIG. 103.—Stone disc. Mound H. (Diameter 7.5 inches.)

and 1.9 inch across the flaring blade. The part formerly occupied by the handle, with 1 inch of the implement projecting behind it, is clearly apparent. At the right wrist were seven great beads of shell and many spool-shaped beads of the same material. Near the right elbow were thirteen pendants of sheet-copper, all similar, but no two exactly alike, each in the form of an arrowhead bearing a *repoussé* eye

FIG. 105.—Hair-ornament of sheet-copper, with bone pin in place. Mound H. (Full size.)

FIG. 104.—Pendants of sheet-copper. Mound H. (Full size.)

(Fig. 104). These lay with the bases together, the pointed ends spread in fan-shaped fashion as if the bases had been strung together through a perforation in each and the points had spread somewhat on the arm. At the left wrist and fore-arm were eight beads of shell, each about an inch in diameter, and a quantity of spool-shaped beads. At the neck were a number of small shell beads. At each side of the head was a wooden ear-plug, copper-coated, the part belonging behind the lobe of the ear being absent, probably through decay. At the skull was a hair-ornament of sheet-copper (Fig. 105) with a pin of bone in place in a socket riveted together to receive it. On the body of the ornament is *repoussé* work, including a delineation of the human head. The small projection at the top of the ornament is fastened on by means of a rivet. Lying on this ornament was a small circle of sheet-copper, .75 inch in diameter, enclosing a five-pointed star (Fig. 106). There is a perforation in the margin and two in the center of the ornament, in which cord remains in place.

FIG. 106.—Ornament of sheet-copper. Mound H. (Full size.)

In addition to the burials noted, we found in the remnant of the mound dug through by us one skeleton full length on the back, and an aboriginal disturbance consisting of a skull and a femur together.

A shell drinking-cup lay apart from human remains.

MOUND I.

Mound I, its soil loosened by cultivation and greatly washed by rain, is a mere wreck of its former self. The area of what is left of the summit plateau is approximately 85 feet north and south by 40 feet east and west. Seventeen trial-holes in the plateau indicated that it had not been used for burial purposes.

MOUND J.

Mound J, somewhat affected by wash, has a shallow and narrow trench following its slope upward on the southern side and continuing part way through the plateau. The sides of the plateau are irregular in length, measuring about 80 feet east and west by 30 feet north and south. Nineteen trial-holes yielded in one instance a few fragments of human bone just below the surface.

MOUND K.

Mound K, largely washed away, has what is left of a summit plateau now 60 feet long by 20 feet broad. An unimportant trench had been dug in from the northern side, expanding considerably in the central part of the plateau. Nine trial-holes were sunk by us, one of which, on the eastern side, came upon half of a large slab of sedimentary rock, with a scalloped margin at the unbroken end, and having a quantity of red paint on one side and red and cream-colored paint on the other. With this fragment was part of a coarse vessel of yellow-brown ware, square in horizontal section, with rude, incised decoration.

Encouraged by this discovery, two more trial-holes were made and a trench was dug, 22 feet 6 inches long by 6 feet broad, 4 feet deep on the summit plateau, and 3 feet deep on the slope, over a part of which it extended. With the exception of a rough ball of earthenware, about 2 inches in diameter, no objects were found.

As the summit plateau had been thoroughly covered by us, the investigation was abandoned with the conviction on our part that while burials had been present, doubtless in the eastern part of the original plateau, they had washed away with the mound, leaving the artifacts found by us, which were near the eastern edge.

Mound L.

Mound L, the sides of which almost exactly coincide with the cardinal points, is bounded on the north and west by a cultivated field, and on the south and east by an artificial pool of water that marks the place whence material for the mound was taken. The summit plateau, which has been under cultivation, is 93 feet long E. and W., and 80 feet broad N. and S., approximately.

The height of the mound is 12 feet 9 inches from the north; from the west, 13 feet 4 inches; from the south, 14 feet 10 inches.

Twenty-five trial-holes, covering the entire plateau, were sunk by us with only negative result.

Next, an excavation 18 feet square, having for its center the central part of the summit plateau, was carried to a depth of 14 feet 10 inches, at which level the excavation was about 13 feet 6 inches by 12 feet 4 inches. The mound showed no distinct stratification. No pits were met, and no sign of dual occupancy; the only artifacts found were several small bits of pottery.

As the base of our excavation, however, still seemed to be composed of disturbed clay, a circular hole 4 feet in diameter was made, which, at a depth of 1 foot 10 inches, came upon homogeneous material, clayey sand of lead color, which extended downward to an unascertained depth. Here we have a domiciliary mound, similar, we believe, to the majority of such mounds, that is, one not put to secondary use as a place of burial.

Mound M.

Mound M, is simply the remnant of what has been a small domiciliary mound, now partly washed away. The dimensions of what remains of its summit plateau are 36 feet by 22 feet. Thirteen trial-holes were without material result.

Mound N.

Mound N, fairly symmetrical, has a summit plateau, about 65 feet square, which has been under cultivation. Twenty-nine trial-holes, without discovery of any sort, convinced us that this mound had not been used for burial purposes.

Mound O.

Mound O, a symmetrical, little mound but slightly affected by wash of rain, and previous to our visit, a stranger to the plough, had been trenched from the

eastern side to beyond the center of the summit plateau. This trench, 8 feet wide at the top, expanded at the end to a circular hole about 13 feet in diameter. Both trench and hole were comparatively shallow, the depth being perhaps from 3 to 4 feet.

The mound, 11 feet 9 inches high from the east and 16 feet 7 inches high from the south, has its longer sides extending almost due north and south. The plateau is about 33 feet by 53 feet in extent.

Nine trial-holes almost at once resulted in the discovery of human remains in two places, and of artifacts in the extreme northeastern part of the mound at a considerable distance from these burials.

As the plateau seemed to have been extensively used for burial, it was completely dug through by us to a minimum depth of from 4 to 5 feet.

Burial No. 1.—This burial lay beneath artifacts discovered by means of one of our trial-holes. Nine inches from the surface was a disc of sedimentary rock, 12.5 inches in diameter (Fig. 107). Around its upper surface, which is somewhat con-

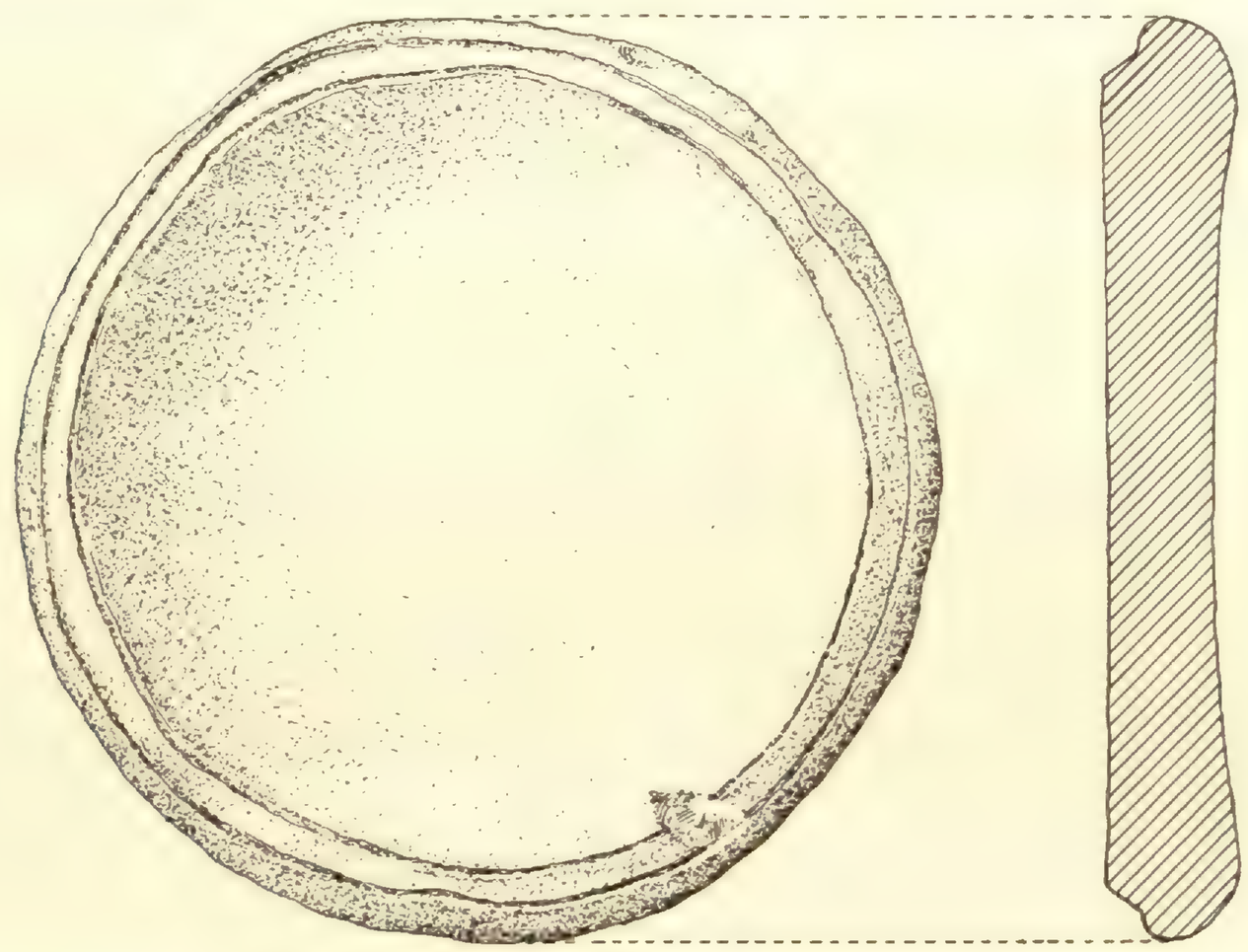


FIG. 107.—Stone disc. Mound O. (One-quarter size.)

cave, are two parallel, encircling lines, rather roughly incised. From the lower surface projects a circular core, the diameter of which is about 2 inches less than that of the upper part.

Nine inches below the slab, was a skull, with a left clavicle, a left humerus, and a few cervical vertebræ. The skull rested on part of the upper surface of a disc of fine-grained gneiss, 9 inches in diameter, having nineteen notches on the margin and two encircling, incised lines on one side. On one surface of the disc are traces of cream-colored paint; on the other surface is much red pigment. Resting on the disc, near the skull, lay an ear-plug of wood, copper-coated, 1.5 inch in

diameter, with a central boss perforated through the middle. In soil thrown out by the digger was found a somewhat smaller disc of wood, overlaid with copper on one side and having a similar central perforated boss. This disc probably formed the part of the ear-plug referred to as being behind the lobe of the ear, while the larger one was worn in front.

Where the left shoulder of the skeleton would have been were two other discs, similar to those just described. These discs, however, were on the same side of the head as the one first found, and therefore, presumably, had undergone disturbance in burial.

A skeleton at full length on the back had on the chest a mass of glauconite, or green earth.

Another skeleton, also extended, had near the skull Vessel No. 1, a small, undecorated bowl.

Vessel No. 2, a bowl of very inferior ware, lay apart from human remains.

Four feet down was a small quantity of decaying, fibrous wood. The former presence of copper with it was shown by a green stain only.

FIG. 108.—Vessel No. 3. Mound O. (Diameter 5.8 inches.)

FIG. 109.—Vessel No. 5. Mound O. (Height 5.75 inches.)

A skeleton at full length to the hips, the rest having been removed by an aboriginal disturbance, had at the skull, Vessel No. 3, a bowl with a rude effigy of an animal-head, and a conventional tail on the opposite side. A fore-leg is indicated on one side of the bowl and a corresponding member doubtless was on the other side; this was missing, but has been restored (Fig. 108). With Vessel No. 3 was Vessel No. 4, an undecorated, wide-mouthed water-bottle in fragments.

An extended skeleton had large shell beads at each wrist, with a few smaller ones intermingled. At the ankles were fifteen great beads of shell, about 2 inches by 1.75 inch by .75 of an inch. Below the chin were a few pearls used as beads, and fragments of sheet-copper. There were also copper-coated objects of wood, resembling ear-plugs, less than an inch in diameter.

FIG. 110.—Stone slab. Mound O. (Length 14 inches.)

Shell beads, badly decayed, were with disturbed bones, as was also a fragment, 4.75 inches in length, of what had been a long, pointed implement of cherty material.

About a foot from a skeleton at full length was a broad-mouthed water-bottle, Vessel No. 5, with parallel, vertical bands alternately cross-hatched (Fig. 109).

With a few fragments of bones were nine large shell beads.

Burial No. 14, 38 inches from the surface, was represented by a single tooth.

FIG. 111.—Stone disc. Mound O. (Diameter 8.5 inches.)

so far as we could determine. Nearby was a slab of fine-grained gneiss (Fig. 110), 14 inches by 9.5 inches, with scalloped ends and incised line decoration on one side. On one major surface of this slab is red pigment, and cream-colored paint is on the other. With the slab was a disc of fine-grained gneiss, 8.5 inches in diameter (Fig. 111), with notches around the margin, and three encircling lines and faint traces of a kind of meander on one side only. As in the case of the slab, the disc has red paint on one side and white paint on the other. Nearby lay a shell gorget, hope-

FIG. 112.—Vessel No. 6. Mound O. (Height 6.75 inches.)

lessly decayed. With this burial was Vessel No. 6, having on two sides the double-headed woodpecker design with a tail extending from each side of the body. The speech symbols are present, but not the extended tongue (Fig. 112). In addition, three fingers are shown near the head of the bird, at each side (Fig. 113).

A copper-coated ear-plug and fragments of sheet-copper were found apart from

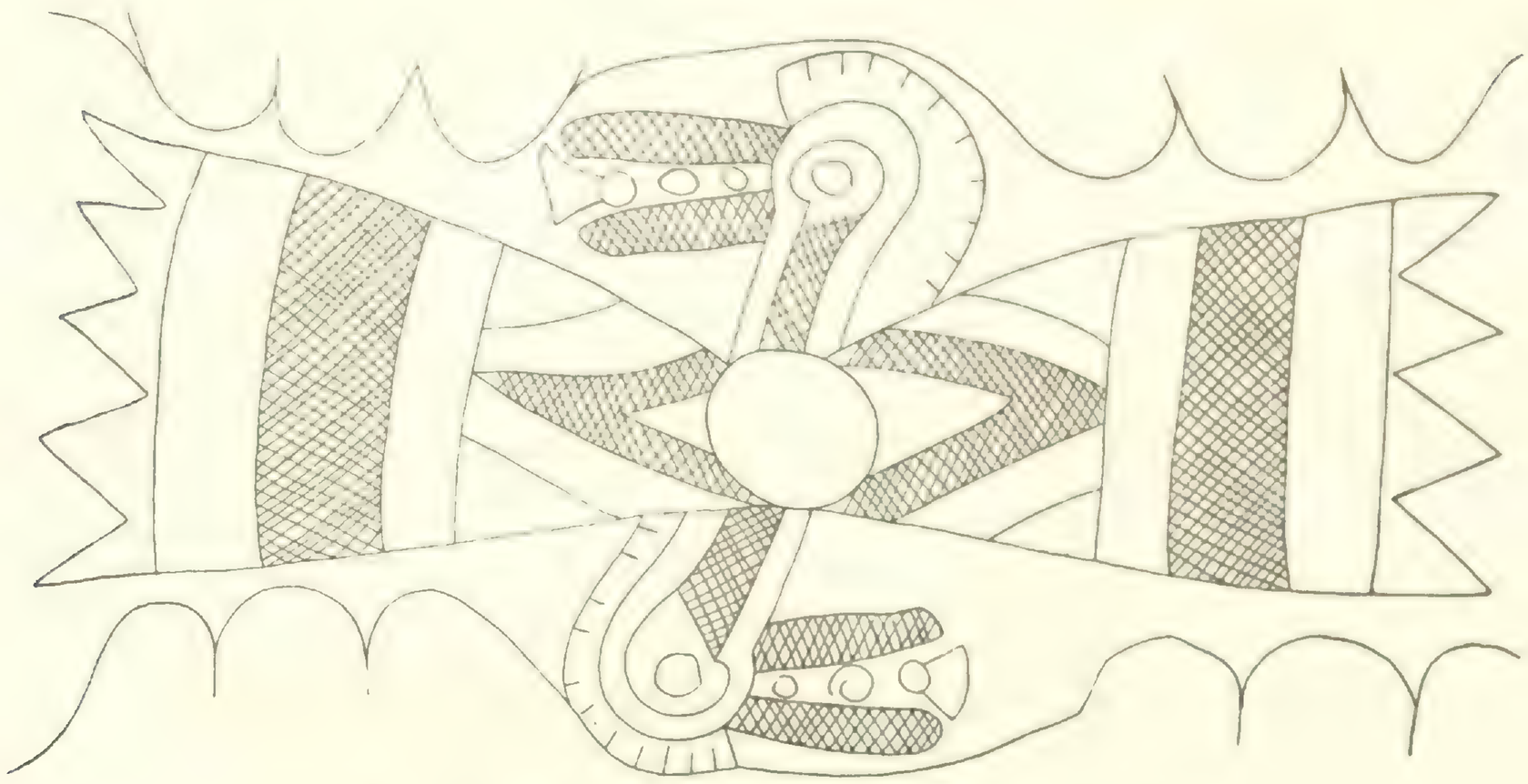


FIG. 113.—Vessel No. 6. Decoration. Mound O. (About half size.)

FIG. 114.—Vessel No. 9. Mound O. (Height 5.9 inches.)

human bones. Elsewhere in the mound a green stain alone denoted the former presence of copper.

With a bunch of bones, perhaps an aboriginal disturbance, was a cylindrical fragment of wood that had been copper-coated.

Vessel No. 7, a small, rude, undecorated bowl, and Vessel No. 8, a rude bowl of inferior ware, were together, with fragments of a wooden ornament, copper-coated, apart from human remains.

About 39 inches from the surface was Burial No. 19. By the order in which they lay, small fragments of bone here and there indicated a full-length burial.

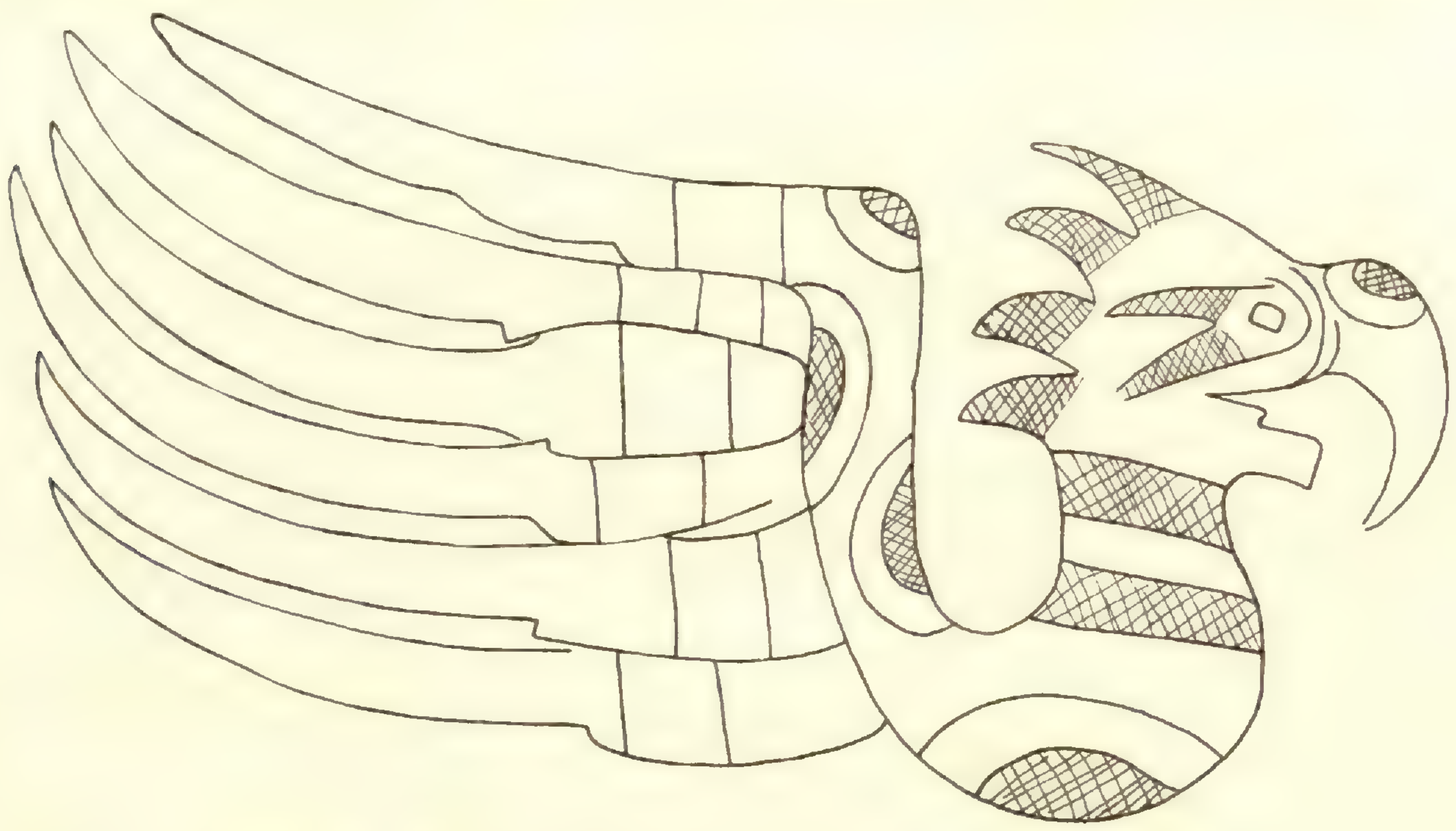


FIG. 115.—Vessel No. 9. Decoration. Mound O. (About half size.)

Near the skull was Vessel No. 9, a wide-mouthed water-bottle showing an engraved eagle on each side (Fig. 114). The two designs, though similar in the main, vary somewhat in detail, especially as to the eye. In the accompanying diagram (Fig. 115), is shown the eagle from the side opposite the one in the half-tone reproduction. Holmes[1] shows engraved eagles, one on a vessel from Mississippi, the other on a water-bottle found by us in northwestern Florida. With the striking water-bottle in Mound O was a disc of fine-grained gneiss, 8.5 inches in diameter, having the customary notches and line decoration (Fig. 116), with paint of three shades,—white, cream-color, and pink—on one side, and red pigment on the other. Placed centrally on this disc was another disc, undecorated, also of fine-grained gneiss, 5.4 inches in diameter, showing considerable pigment.

With a burial of scattered bones, perhaps an aboriginal disturbance, near the skull, was Vessel No. 10, in fragments. Cemented together, the vessel shows the design of the woodpecker on each of two sides, with speech symbols and extended tongue, but with a variation in the tails where the individual feathers are not represented as pointed (Fig. 117). Probably, for the purpose of gaining space, the lower head has been made smaller than the upper one, as shown in diagram in Fig.

[1] *Op. cit.*, Pl. LI (fig. e), and Pl. LXIX.

FIG. 116.—Stone disc. Mound O. (Diameter about 8.5 inches.)

118. With Vessel No. 10 was Vessel No. 11, a wide-mouthed water-bottle in fragments.

Near an isolated skull were Vessels Nos. 12 and 13, respectively a small pot with loop-handles and a rude bowl in fragments, having incised line decoration under the rim.

Lying apart from human bones, which perhaps had decayed away or had been disturbed in aboriginal times, were the outer half of an ear-plug of wood, copper-

FIG. 117.—Vessel No. 10. Mound O. (Height 6.25 inches.)

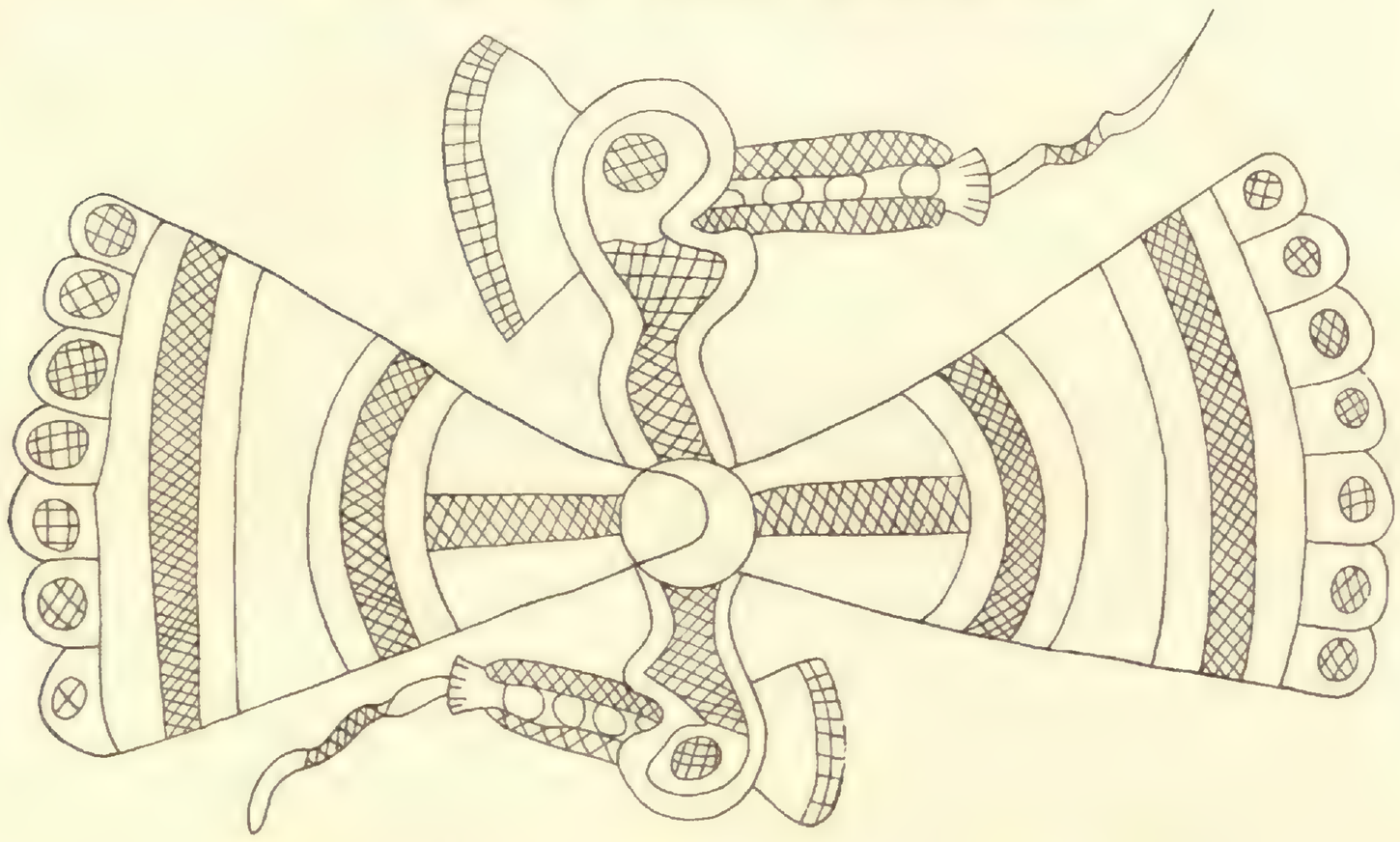


FIG. 118.—Vessel No. 10. Decoration. Mound O. (About half size.)

coated; Vessel No. 14 (Fig. 119), a broad-mouthed water-bottle, having for decoration depressions surrounded by scrolls; and Vessel No. 15 (Fig. 120), a cup with incised ribbon-fold decoration, which was found inverted on the neck of the water-bottle.

FIG. 119.—Vessel No. 14. Mound O. (Diameter 5.4 inches.)

FIG. 120.—Vessel No. 15. Mound O. (Diameter of body 4 inches.)

FIG. 121.—Vessel No. 16. Mound O. (Height 5.5 inches.)

Vessel No. 16 is a broad-mouthed water-bottle, found in fragments which, put together (Fig. 121), present a design shown in diagram in Fig. 122.

A burial represented by a few teeth had with it Vessels Nos. 17, 18, 19. Vessel No. 17, of inferior ware, lay in fragments. Vessel No. 18 (Fig. 123), a wide-mouthed water-bottle, has a decoration consisting of down-turned hands alternating with open eyes. On each hand is a symbol, perhaps a conventionalized eye.

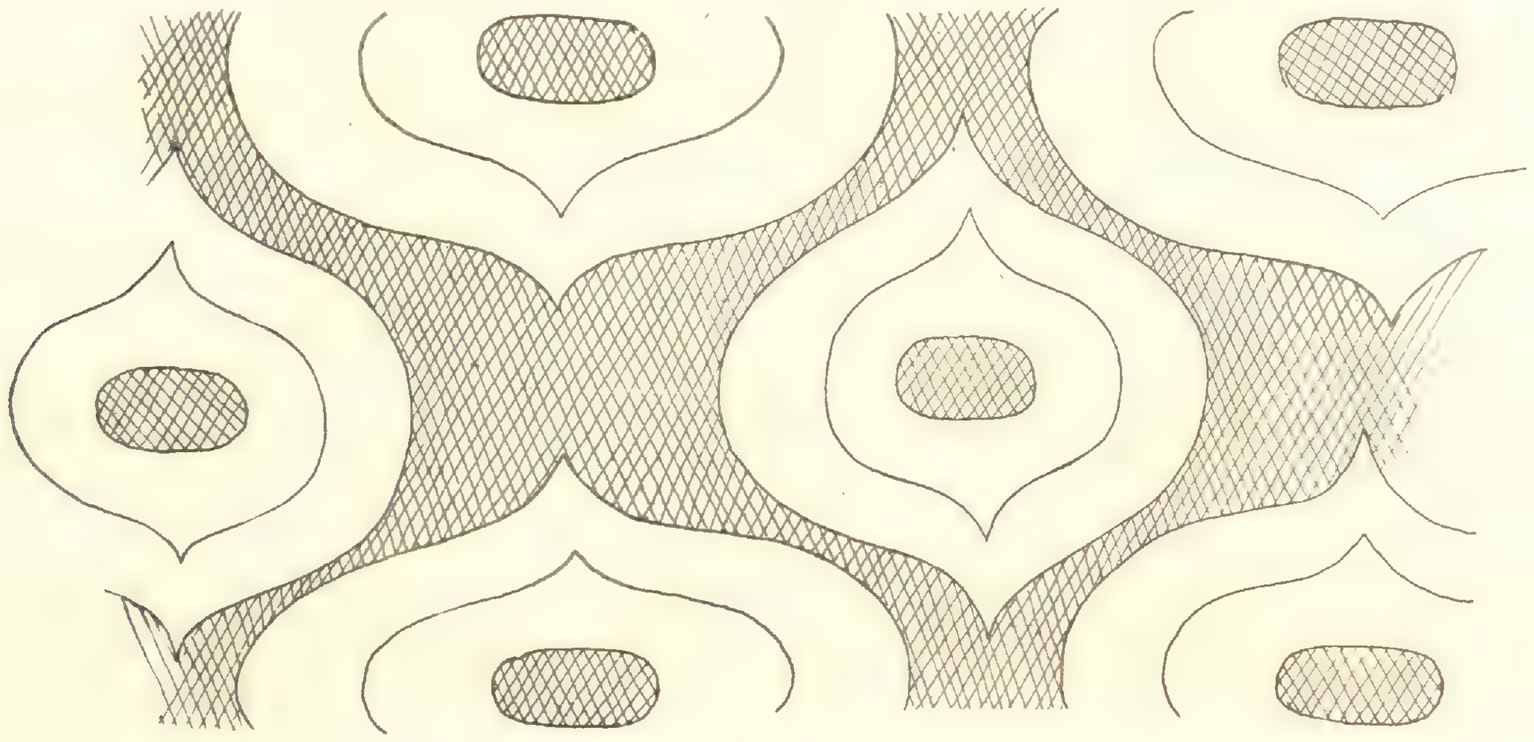


FIG. 122.—Vessel No. 16. Decoration. Mound O. (About half size.)

FIG. 123.—Vessel No. 18. Mound O. (Height 6.75 inches.)

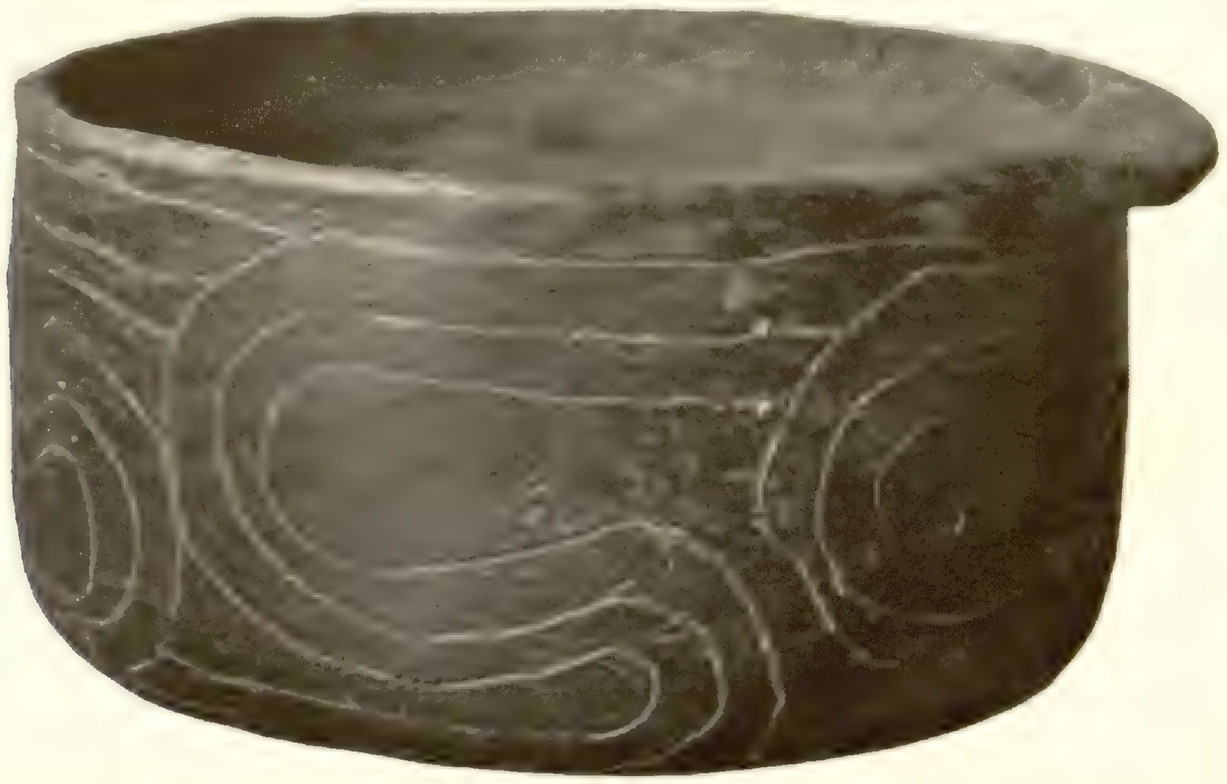


FIG. 124.—Vessel No. 19. Mound O. (Diameter of bowl 4 inches.)

Vessel No. 19 (Fig. 124), a cup with a meander decoration, was found partly filled with a mass of material which analysis by Dr. H. F. Keller showed to be glauconite, or green earth, the green color being derived from the presence of iron in the ferrous state. This earth might have been, and doubtless was, used as a temporary paint. The color, however, would soon darken through oxidation when

FIG. 125.—Vessel No. 20. Mound O. (Height 5.2 inches.)

exposed to the air. On the glauconite within the cup was a mussel-shell containing red pigment. With these vessels was a slab of stone, undressed as to its sides, having a certain concavity of each broad surface, on one of which was red paint.

Vessel No. 20 (Fig. 125) lay in fragments in a pit near bones, but was not attributable to any burial in particular. The design, similar to

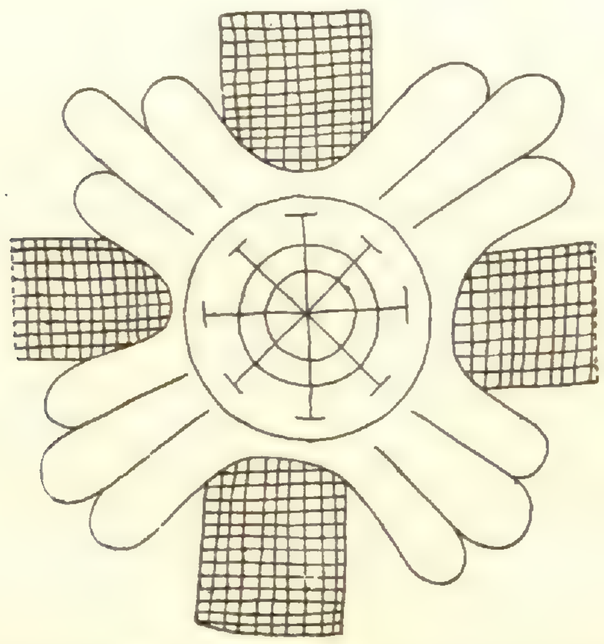


FIG. 126.—Vessel No. 20. Decoration. Mound O. (About half size.)

several found at Moundville, but not noted elsewhere, so far as we know, consists of the sign of the four quarters represented by series of three digits pointing in the four directions. Centrally are series of concentric crosses and circles. Between each series of digits is cross-hatch, as shown in diagram in Fig. 126.

Vessel No. 21, a small, undecorated, wide-mouthed water-bottle, lay inverted in a pit where, seemingly, it had been tossed in a disturbance in aboriginal times. This vessel bears a perforation in the base, presumably the result of accident at its first disinterment.

Near a disturbed burial was a disc of fine-grained gneiss, 7 inches in diameter, having the usual decoration, with traces of white paint on one side and red on the other.

FIG. 127.—Ceremonial weapon of chert. Mound O. (Full size.)

Near the surface of a pit containing several burials at greater depth, was a ceremonial weapon of cherty material, shown in Fig. 127.

Vessels Nos. 23, 24, and 25, are all undecorated bowls found in fragments, away from human remains.

Vessel No. 26, with only a fragment of decaying bone nearby, in caved soil, was a graceful water-bottle with a decoration so faint that it can just be distinguished in the half-tone reproduction (Fig. 128).

FIG. 128.—Vessel No. 26. Mound O. (Diameter 4.75 inches.)

With disturbed bones were corroded fragments of what seem to have been hair-ornaments of sheet-copper, but their incomplete condition make absolute identification impossible.

Vessel No. 27, found alone, is an undecorated, wide-mouthed water-bottle (Fig. 129).

Apart from human remains was Vessel No. 28, a broad-mouthed, undecorated water-bottle (Fig. 130), with Vessel No. 29, a small, undecorated pot that once had been provided with two loop-handles.

Burial No. 37 consisted of a deposit of fragments of calcined human bones at the bottom of a pit 32 inches deep. This pit, which had a maximum diameter of 19 inches, had contracted to 13 inches where the calcined fragments were. The calcined deposit, somewhat less in diameter than the pit, had a depth of 9 inches. Throughout the soil above the deposit were other fragments of calcined bone.

Vessel No. 30, a bowl in fragments, unassociated with human remains, has five encircling, incised lines below the rim.

FIG. 129.—Vessel No. 27. Mound O.
(Height 6.5 inches.)

FIG. 130.—Vessel No. 28. Mound O.
(Height 5.5 inches.)

FIG. 131.—Effigy-pipe of stone. Mound O. (Height 8 inches.)

In the southwestern corner of the mound, 3 feet down, were two effigy-pipes. One, of carbonate of lime, representing an animal, had so deteriorated through lapse of time and long contact with moisture that the consistency was about that of clay; in fact, the clay surrounding the pipe was of greater tenacity than it, as, upon removal, the pipe left small particles adhering to the soil. The other, found lying

FIG. 132.—Effigy-pipe of stone. Mound O. (Height 8 inches.)

on its side, immediately with the one just described, is a fine effigy-pipe of soft, red claystone, 8 inches high, representing a squatting male figure, shown in both front and side view in Figs. 131, 132. Unfortunately the knees, part of the right arm, the right hand, and part of the left hand, of the effigy, had all been broken off

FIG. 133.—Vessel No. 31. Mound O. (Diameter of bowl 4.75 inches.)

FIG. 134.—Gorget of sheet-copper. Mound O. (Full size.)

before interment and hence were not found. These pipes were not immediately associated with burials, though human bones were found not far distant.

FIG. 135.—Vessel No. 37. Mound O. (Diameter 4.25 inches.)

With disturbed bones, together, were Vessels Nos. 31, 32, and 33. Vessel No. 31, a cup, has a kind of meander in a cross-hatch field (Fig. 133). Vessel No. 32 was badly broken. Vessel No. 33, also in fragments, proved to be a small bowl with slightly inverted rim and incised decoration consisting of two encircling, parallel lines passing under four equidistant protuberances situated slightly below the rim.

With Burial No. 40, a skull and a few decaying bones probably representing a skeleton, were Vessels Nos. 34 and 35. Nearby were Vessel No. 36, in fragments, and a mass of galena (lead sulphide) the surface of which is coated with a cream-colored deposit of carbonate of lead, suitable for use as paint. Vessel No. 34 is a small, coarse, undecorated, wide-mouthed water-bottle. Vessel No. 35, a small, coarse bowl, has rudely executed, incised, curved lines below an in-turned rim. Vessel No. 36 was badly broken. Adhering to fragments of bone belonging to the trunk of this burial, enveloped in decayed wood or bark, was a circular gorget of sheet-copper, 6.5 inches in diameter, which broke slightly on removal. This gorget, pieced together, shows a central swastika formed by excision, surrounded by many *repoussé* circles (Fig. 134).

Vessel No. 37, of eccentric form (Fig. 135), is of a type once before represented in our search at Moundville, in which a portion of the rim is much lower than the remainder. This vessel has been repaired and slightly restored.

In the northeastern corner of the mound, near a disturbed burial, was an ornament of sheet-copper in fragments and a small mass of lead sulphide. At the distal end of one femur belonging to this burial were large shell beads, and similar shell beads were at the distal extremities of the leg bones, which were in the pit at some distance from the femurs.

With a burial was a ball of black substance, about two inches in diameter, showing various facets where presumably material had been rubbed off for use as paint. Analysis by Dr. H. F. Keller proved the mineral to be psilomelane, a hydrated peroxide of manganese containing considerable quantities of oxide of cobalt.

Shell beads twice, fragments of sheet-copper twice, and single ear-plugs three times, were found in this mound in addition to examples given in detailed description.

In this mound human bones were met with in forty-two places, exclusive of

small fragments here and there. The burials, very badly decayed, were scattered to a much greater extent than were most of those encountered by us at Moundville. Presumably the superficial part of the mound had been dug and redug for burial purposes to such an extent that but few entire burials remained.

The situation in which burials occurred in this mound was contrary to what had been found to be the general rule, for while two or three burials were present in the northeastern corner, no other burials were met with in the eastern part of the mound until the southeastern corner was reached. On the other hand, burials were numerous along the entire western side with the exception of the southwestern corner. Certain burials were present in the northwestern part and some in central parts.

This symmetrical mound was carefully filled by us, as were all others at Moundville where dug into by us; in addition, as we had encroached somewhat on the sides of Mound O, boards were placed at marginal points, projecting above the soil, to prevent subsequent wash of the soft material.

Field East of Mound O.

Near the base of Mound O, on the eastern side, a number of trial-holes were dug by us in a cultivated field, resulting in the finding of an adult skeleton, extended on the back, and, in another place, the skeleton of an infant, having near the head an interesting little vessel with incised line decoration and projections at each end (Fig. 136).

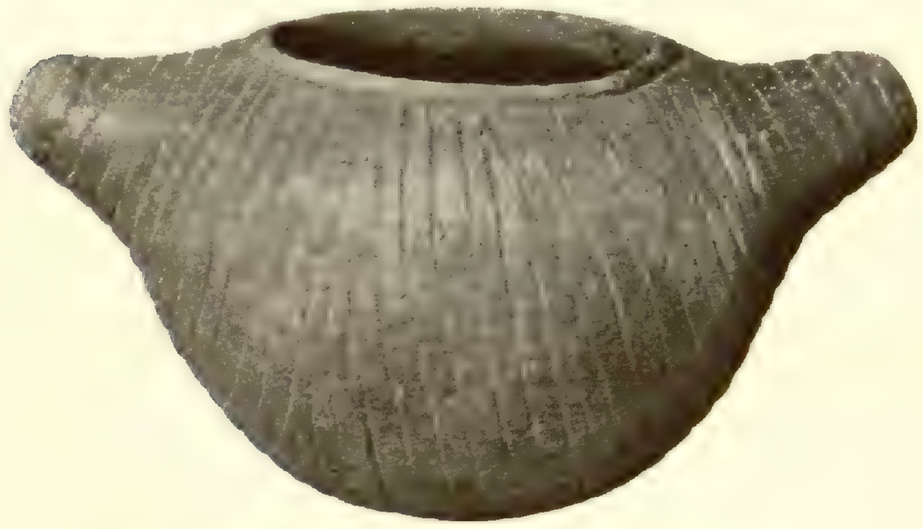


Fig. 136.—Vessel No. 1. Field east of Mound O. (Maximum diameter 3.75 inches.)

Fig. 137.—Ornament of earthenware. Field east of Mound O. (Full size.)

Apart from human remains, in other holes, were a small discoidal of amphibolite and a flat, polished, annular ornament of hard earthenware, about 1.75 inch in diameter (Fig. 137). This ornament is provided with two holes for suspension and a central opening surrounded by incised decoration. The object seems to have been made expressly for an ornament and not shaped from a fragment of vessel.

Mound P.

Mound P has a summit plateau 75 feet in width on the north and on the south, and 95 feet long on the west. Its length on the eastern side is 120 feet. The plateau has a very decided slope downward from south to north. Twenty trial-holes revealed no sign of burials or of pits.

Mound Q.

Mound Q showed no sign of previous cultivation or of digging for relics, though much of the eastern side had been destroyed apparently to make a roadway to the top of the mound at the northern end, presumably for a house that may have occupied the plateau in recent times. The summit plateau, 57 feet across on the north, 43 feet on the south, 52 feet on the west, and but 19 feet on the east where the road entered, had rather rich soil in places, which often indicates the presence of burials. Nine trial-holes were made without finding burials, though the earthenware head of an owl, which had belonged to a

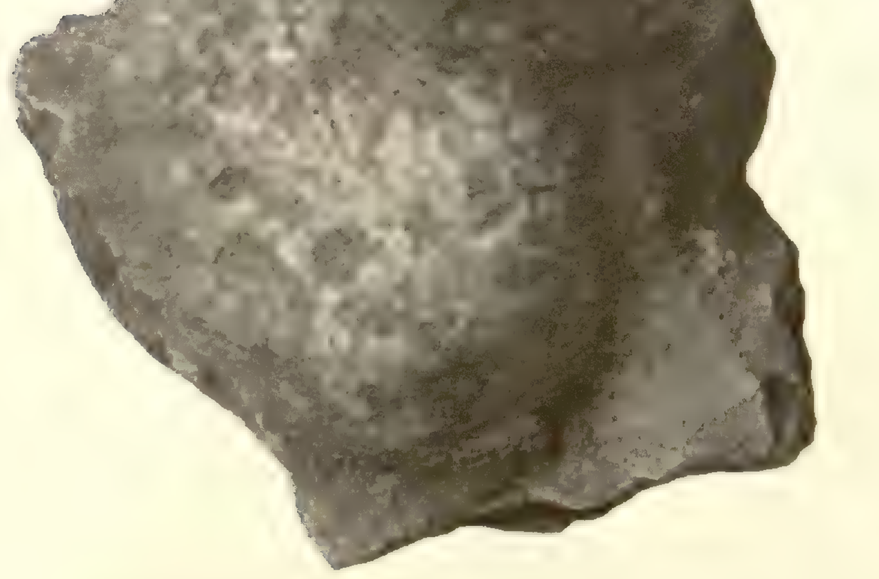


FIG. 138.—Part of earthenware vessel. Mound Q. (About full size.)

FIG. 139.—Ornament of sheet-copper. Mound Q. (Full size.)

vessel (Fig. 138), and a small ornament of sheet-copper, representing a six-pointed star within a circle (Fig. 139), were met with in the soil.

FIG. 140.—Vessel No. 1. Field north of Mound Q. (Diameter 4.5 inches.)

Field North of Mound Q.

Directly north of Mound Q was a small cultivated patch of ground in which some digging was done by us. It became apparent, however, that, owing to cultivation and wash of rain, burials had been carried away or left so near to the surface that their accompanying artifacts had sustained injury from the plow.

A skeleton at full length on the back had at its head a small pot with two loop-handles and *repoussé* decoration (Fig. 140).

A number of other burials were without artifacts.

Mound R.

Mound R, with a summit plateau 165 feet by 180 feet, approximately, which had long been under cultivation, had the appearance of having lost about 3 feet in height over much of its horizontal surface through cultivation and wash of rain. This conclusion was reached from the fact that, at the edge of the plateau, in places where the roots of trees hold the soil, the level is several feet above that of the rest of the plateau. On the other hand, it is possible that the elevated portion of the plateau is the remains of a rampart or wall that originally surrounded the plateau and that the trees growing upon this raised portion are not the cause of its existence but simply were allowed to remain when the rest of the plateau was cleared for cultivation, because the part on which the trees are was too steep for use. Twenty-seven trial-holes in this plateau gave no indication of its former use as a place of burial.

Ridge North of Mound R.

Northwest of Mound R, is an old-time cemetery for colored persons. Reports are current in Moundville that in digging graves at this place many relics have been unearthed, but considerable investigation by us on the borders of this cemetery were without material result.

East of the cemetery are a patch of cultivated ground, then a strip of land with trees upon it, and, beyond, another cultivated patch. The wooded strip, about 200 feet long and 50 feet across, is bounded on the north by the river bluff and on the south by Mound R. The northern 75 feet of this tract (marked U on the survey), which formed a ridge or low mound somewhat above the level of the remainder of it, which was that of the adjacent fields, were thoroughly dug through by us to a depth of from 3 to 4.5 feet. Even at this depth it was impossible to say that undisturbed ground had been reached in all cases, as fragments of pottery and other midden refuse lay at still lower levels. Presumably this territory had long been occupied as a dwelling site. No pits, however, extended to a depth greater than 4 feet, and it was in pits that burials seemed to occur.

A considerable area surrounding this ridge, including the southern part of the wooded strip from which the ridge rose, was dug by us extensively but with only negative result.

The low ridge dug by us, which attained its maximum height almost at its northern end, contained a few burials here and there throughout; but the great majority of interments and all artifacts of importance came from the northeastern end, where grave-pits had been dug and redug to the great detriment of skeletons and of objects buried with them.

At intervals in the mound were pits, some of considerable size, containing refuse and apparently not intended for burial purposes. One pit, which began 30 inches from the surface and evidently had been formed during the accretion of the mound, was 10 inches deep and 14 inches in diameter. Bordering it were marks of fire, and clay hardened by flame. In this little pit, or oven, were ashes, charcoal, bits of pottery, and deer-bones.

In the mound also were flat fire-places, one at least having clay hardened like brick from continued heat.

A pot-shaped deposit, 8 inches in diameter, 6 inches deep, beginning 2 feet from the surface, seemingly composed of slips of charred cane, was found away from human remains.

Also apart from human bones was a deposit of charred woven material and charcoal.

Remains of the deer were scattered throughout the mound. In one place were bones of what must have been a large part of the carcass of one.

Throughout the mound was the usual midden refuse and other objects, including bits of mica, a number of rough discoidal stones, hammer-stones, pebbles, hones, pitted stones, and a great number of fragments of polished "celts." These fragments, which had been broken by use and not in process of manufacture, as the high polish on parts of them show, number from forty to fifty. They were present in all parts of the mound and were found with burials twice—probably an accidental association. This great number of fragments of "celts" in a mound or dwelling-site is new in our experience.

But one unbroken "celt" was met with—a neatly made hatchet of volcanic rock, 4 inches long, lying apart from any burial.

Also in the mound were two fragments of scalloped stone discs.

Throughout all the digging of this low mound but one arrowhead was met with—a small projectile point of red jasper. This fact emphasizes the marked scarcity of arrowheads noted by us during our digging, and throughout our surface surveys, at Moundville.

In all the digging in this low ridge but one fragment of quartzite was found, so far as our observation went. Abundance of this material, however, lay on the surface of the field north of Mound D.

Part of an interesting pipe, probably of stone belonging to the amphibole group, with the head of a turtle projecting from the bowl, lay alone in the soil (Fig. 141). Similar protruding heads of turtles are found on vessels of earthenware along the northwestern Florida coast.

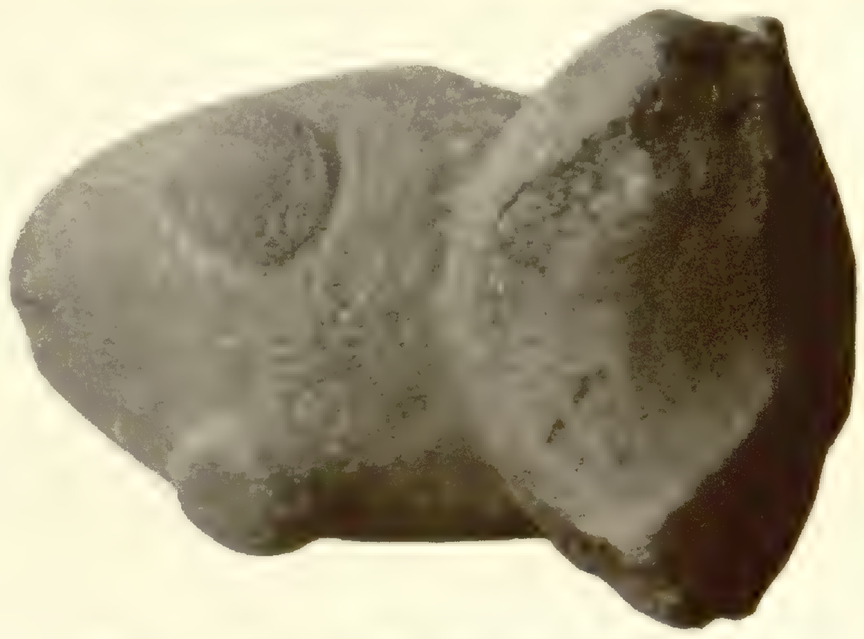


FIG. 141.—Part of stone pipe with head of turtle. Ridge north of Mound R. (Full size.)

Two small, flat slabs of hematite, each with several facets as if produced by rubbing, were found separately.

Throughout the mound were fragments of very large vessels, of coarse shell-tempered ware, evidently belonging to cooking utensils, many with loop-handles, calling to mind the great vessels found by us along the Alabama river where, however, they had been utilized for urn-burials.

Several effigies of heads of birds were met with, including the head of an owl, ornaments which had been broken from earthenware vessels.

Many fragments of excellent black ware were scattered throughout the mound, especially in the northeastern part, where most of the burials were. These fragments presumably belonged to vessels that had been placed with burials but which later were broken in the digging and redigging of that part of the mound in which they occurred. One sherd of excellent ware and with artistic decoration is shown in Fig. 142.

A part of a cooking vessel, with a series of small loop-handles below the rim, lay in the mound.

FIG. 142.—Sherd. Ridge north of Mound R. (Full size.)

There were found also pottery discs made from parts of vessels; two stopper-shaped objects of earthenware, one somewhat broken; part of what seems to have been a toy ladle of pottery; and part of a disc of pottery not made from a fragment of vessel but directly as an ornament, as is shown by the surface which is polished although there is a gradation in thickness between the central part and the margin. Around the margin are notches, and incised decoration is on one side of the specimen. There are two holes for suspension.

Two piercing implements of bone, several tines of deer-horn, and various mussel-shells, one very large (*Lampsilis purpuratus*), were in the midden debris.

In a mound where there had been so much disturbance, one burial often displacing another, an exact record of the number of burials and their form is impossible to give. In cases where a burial obviously had been made in a certain way, but had undergone partial disturbance, it has been classed by us under its original form. We have designated as aboriginal disturbances such bones as were too much scattered to afford evidence of their original positions. Burials lay from just below the surface to a depth, in one instance, of 4 feet. There were in the mound:

Skeletons at full length on the back, including two children—38.
Aboriginal disturbances, including seven children—15.
Skeleton flexed on the right side—1.
Skeleton flexed on the left side—1.
Skeleton of child, partly flexed—1.
Bones of infant—1.
Decayed bones of child—1.
Bones of children disturbed by our diggers—2.
Bunched burials, including that of a child—3.
Lone skull—1.

The vessels of earthenware from this mound will be described in detail.

Vessel No. 1.—This vessel, a broad-mouthed water-bottle of highly-polished, black ware (Fig. 143), lay near the skull of a child. The decoration consists of the symbol of the four quarters, the cross, which is here represented by four series each of three digits having conventional finger-nails. In addition, are depressions in the body of the vessel, series of fingers pointing upward and downward, and certain cross-hatch decoration, as shown in diagram in Fig. 144. Designs generally similar to that on this vessel, but varying somewhat in minor details, were found several times at Moundville. With Vessel No. 1 were a shell drinking-cup (*Fulgur perversum*), and Vessels Nos. 2 and 3, respectively, an undecorated, broad-mouthed water-bottle and a rude bowl bearing in effigy the head of some animal, looking inward.

Vessel No. 4.—An undecorated water-bottle (Fig. 145) lay at the head of a skeleton.

Vessel No. 5.—In the outskirts of the mound, away from human remains, was a large part of a coarse cooking-pot. Within this fragment was a beautiful toy-bowl, 1.5 inch in diameter and 1 inch in height, symmetrically wrought from a chocolate-colored, banded stone.

Vessel No. 6.—A neat little bowl with inverted rim, having faint, incised decoration, found at the head of a skeleton.

Vessel No. 7.—A bowl in fragments, lying near the skull of a child.

Vessel No. 8.—About two-thirds of a bowl having a large, flat handle projecting horizontally from one side. The opposite part of the bowl is missing.

Vessel No. 9.—A skeleton at full length on the back had charcoal at the feet and minute fragments of a sheet-copper ornament nearby. At the head was a wide-mouthed water-bottle (Fig. 146)[1] bearing an engraved decoration, one of the most remarkable it has been our good fortune to encounter. This design, shown in diagram in Fig. 147, consists of four skulls facing each other in pairs, with two skeleton arms and heads between them. In addition, two symbols are given, the meaning of which is entirely beyond our ken. The skulls show the sutures and

[1] The design has not been strengthened on the vessel, nor has retouching been done on the photographic negative. A white powder has been rubbed into the lines of the design in order to bring them out more clearly in the photograph.

Erratum.—In the second line from the bottom of this page the word "*heads*" should be "*hands.*"

FIG. 143.—Vessel No. 1. Ridge north of Mound R. (Height 5.75 inches.)

the orbits, but part of the lower jaw is incorrectly placed, being portrayed as extending beyond the occipital part of the skull.

While it is possible that this anatomically incorrect representation of the lower jaw arose through ignorance, it should be remembered that the aborigines of Moundville were very familiar with the human skeleton, lying exposed, as it did, in the dead-houses and later being a center of interest during the performance of funeral rites.

Possibly the lower jaw was accentuated by the artists of Moundville because of its being regarded as a symbol of importance, as it was by the Mexicans, and perhaps this consensus of opinion arose through "parallelism of thought."

On the other hand, it seems likely enough that the people of Moundville, to

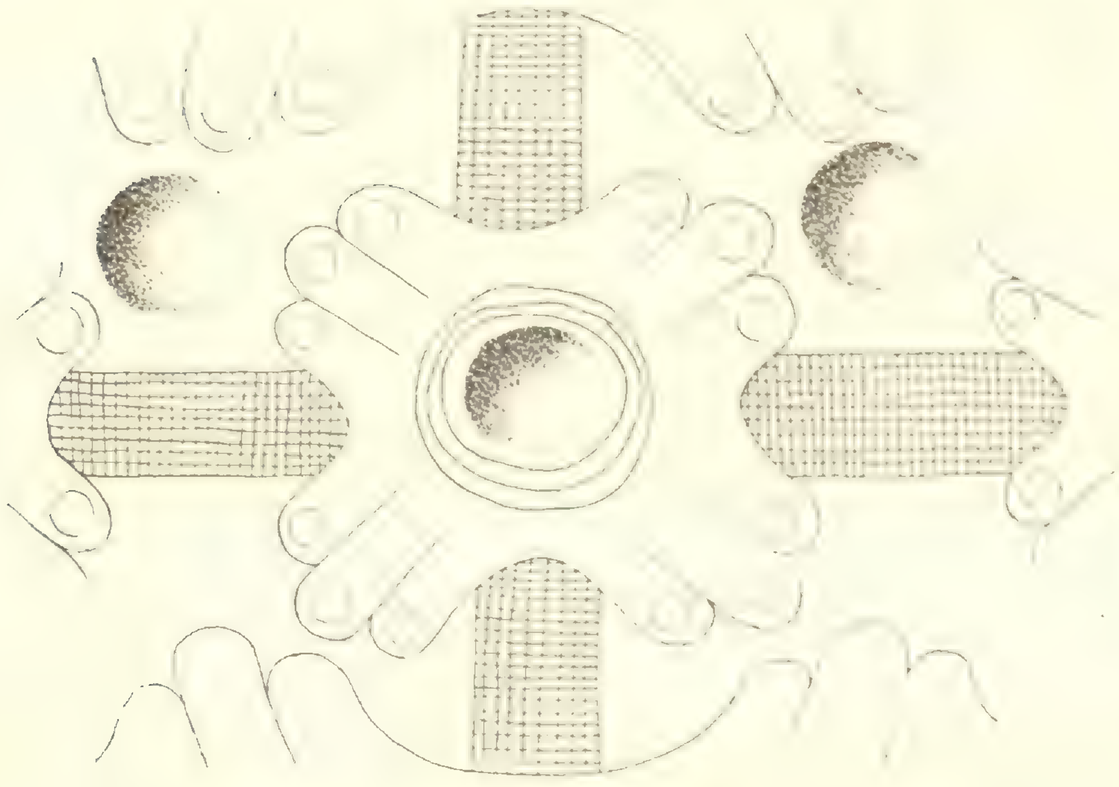


FIG. 144.—Vessel No. 1. Decoration. Ridge north of Mound R. (About half size.)

FIG. 145.—Vessel No. 4. Ridge north of Mound R. (Diameter 7 inches.)

FIG. 146.—Vessel No. 9. Ridge north of Mound R. (Full size.)

some extent, were directly influenced from Mexico. If such were the case, the cause of the misrepresentation of the ramus on these skulls would not be far to seek. The Mexican codices are replete with representations of the lower jaw, shown in place in the skull and in the head, and sometimes even drawn alone, flattened out, as in a diagram, or represented as a receptacle for various objects. In many, if not in all, of these representations the articular process is exaggerated, being given the form of a hook. Presumably this was done because the artist regarded the articular process as a distinctive feature of the lower jaw and hence was determined that it should not escape attention. Miss H. Newell Wardle, of our Academy of Natural Sciences, to whom we are indebted for many references on this subject, has called our attention to the point that, presumably, this emphasizing of the articular process of the lower jaw is an expression of the æsthetic

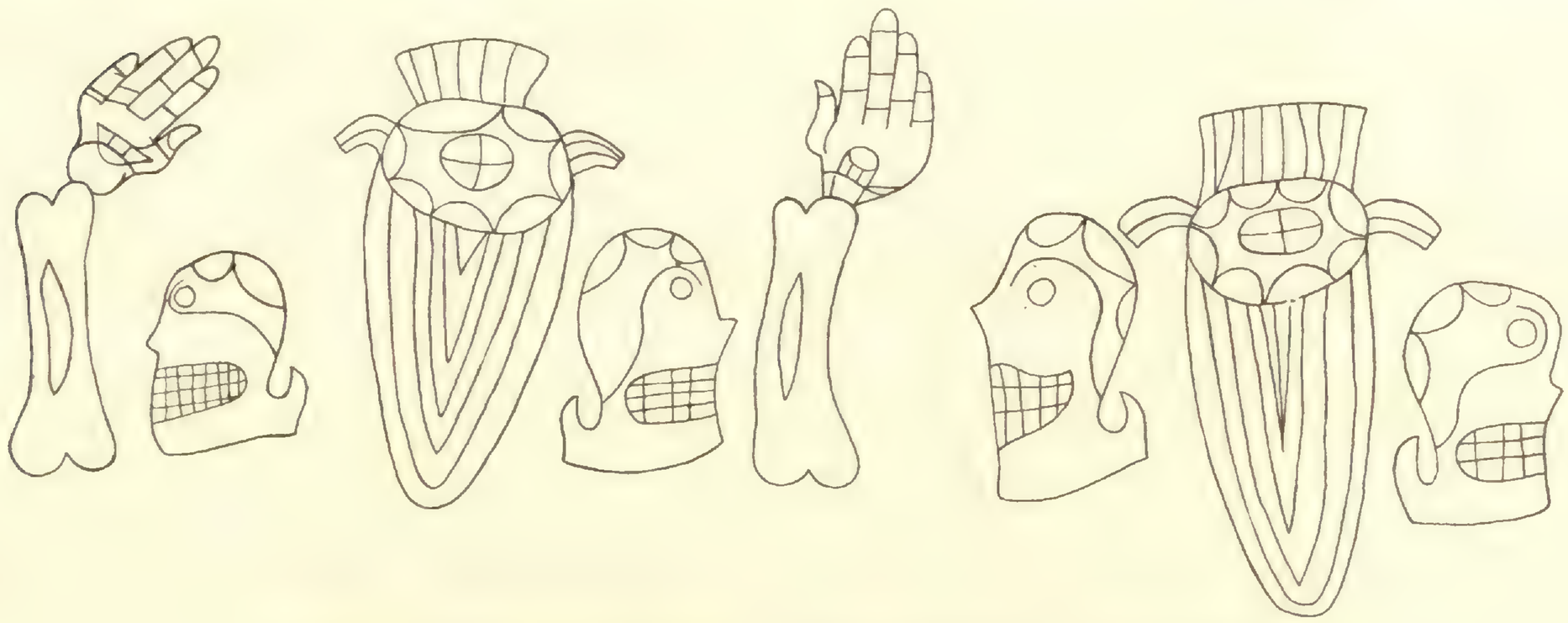


FIG. 147.—Vessel No. 9. Decoration. Ridge north of Mound R. (About half size.)

law familiar from the northwest coast of America, where the dorsal fin of the orca is always placed conspicuously in representation, though in a majority of cases it would be invisible from the view-point. In the same way, the Egyptians show the human eye, when the head is in profile, very much as if the human head conformed anatomically to that of a fish.

So determined was the Mexican artist that the essential attributes of the lower jaw should not escape attention that we see the jaw, represented in place in the skull, still showing the articular processes, although presenting a front view to the observer. A good example of this is shown in Codex Magliabecchiano.[1]

The codices, however, it must be noted, so far as our search goes, show no such great exaggeration of the articular part of the lower jaw, or perhaps of the whole ramus, as we find at Moundville, where part of the lower jaw is represented as extending beyond the occipital part of the skull.

The skeleton fore-arm shown on this vessel from Moundville, with the radius and ulna distinctly represented, has a parallel in many figures in the codices. An

[1] XIII, 3, p. 76.

interesting example is given in Codex Nuttall,[1] where Mictlantecutli, "lord of the place of the slain," shows the ribs, vertebræ, the bones of both lower extremities, of one upper arm, and of both fore-arms. Curiously enough, a peculiarity of most of the Mexican figures of the death-god is that to correspond with the double bones of the lower arm and the leg, the humerus of the upper arm and the femur of the thigh are shown as double bones also—a feature well brought out in the figure to which we have referred.

The reader is referred to a few of very many representations in the codices, of the lower jaw and of skeletal extremities.[2]

FIG. 148.—Vessel No. 11. Ridge north of Mound R. (Height 5.4 inches.)

Holmes[3] shows a death's head design on a vessel from Mississippi.

Vessel No. 10, a small, wide-mouthed water-bottle, lay with the scattered bones of a child, with which were two shell beads, each about an inch in length.

Vessels Nos. 11 and 12 were together near a few scattered bones. The former, a wide-mouthed water-bottle (Fig. 148), has five depressions on the body, with each

[1] P. 78, lower right-hand corner.
[2] Codex Vaticanus B., pp. 75, 76.
Codex Laud, Kingsborough, II, p. 11.
Codex Borgia, Loubat edition, Pl. XXVI.
Codex Borgia, Kingsborough, III, pp. 59, 63, 65.
Codex Cospiano, Loubat edition, Pl. IX, X, XI.
Codex Tejervary-Mayer, Pl. III, XXXII.
[3] *Op. cit.*, Pl. LVI.

of which is a design probably representing an arrow and the sun. Vessel No. 12 is a small, undecorated dish of coarse, yellow ware.

Vessel No. 13 is a diminutive, wide-mouthed water-bottle, undecorated, scarcely more than 2 inches in height. This little bottle, found dissociated from human bones, was in a pit where aboriginal disturbance, no doubt, had separated it from its burial.

Vessel No. 14, a bowl with parts of a water-bottle, badly crushed, lay not immediately associated with bones, though as at least seven burials lay in the pit in which the vessel was found, the cause of the separation may well be imagined. With it were crumbling fragments of sheet-copper and a shell gorget (Fig. 149), bearing a bird decoration, which received a blow from a trowel.

Vessel No. 15, a wide-mouthed water-bottle with scroll decoration and four groups of three finger-tips each, pointing downward, lay badly crushed at the head

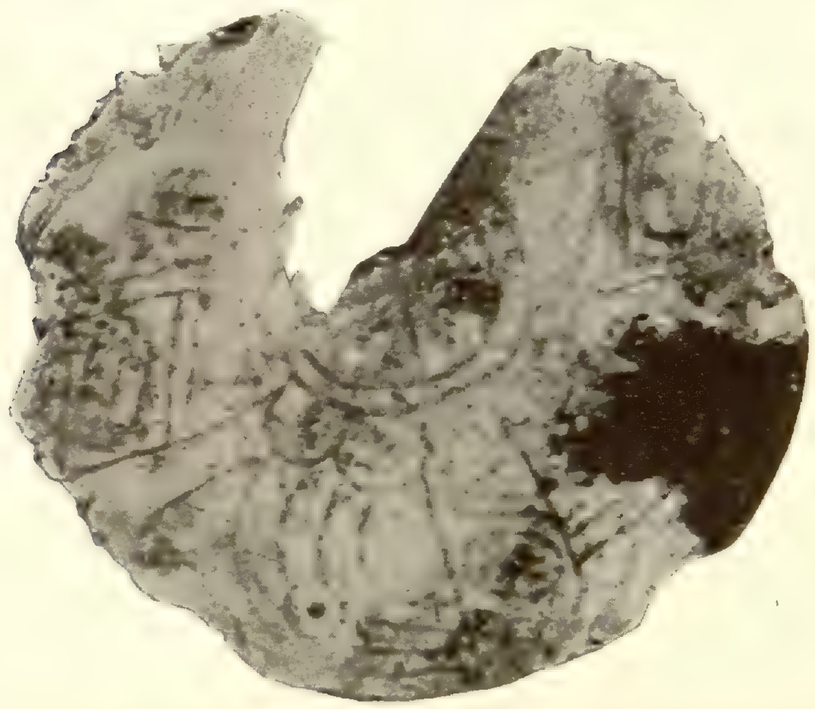


FIG. 149.—Shell gorget. Ridge north of Mound R. (Full size.)

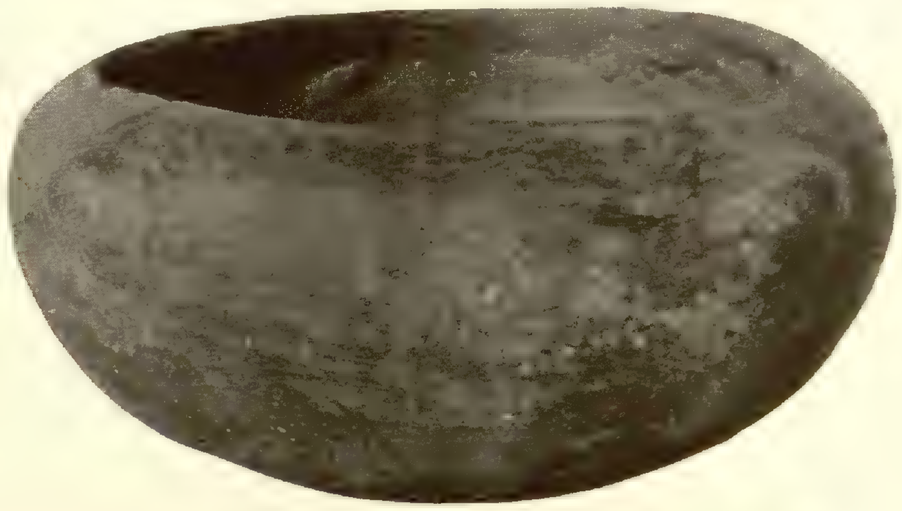


FIG. 150.—Vessel No. 15*a*. Ridge north of Mound R. (Diameter 5.5 inches.)

of a skeleton. With this vessel was Vessel No. 15*a*, part of a small bowl with four equidistant protuberances (Fig. 150).

Vessel No. 16, is a broad-mouthed water-bottle in fragments scattered through a pit, having the well-known depressions and scroll decoration.

Vessel No. 17, a broad-mouthed water-bottle (Fig. 151), found at the head of a skeleton, bears on opposite sides an engraved design representing an antlered and winged rattlesnake with forked tongue extended. This design, which we give diagrammatically in Fig. 152, suggests the winged and crested rattlesnake shown by Holmes[1] as on a vessel from Arkansas, and referred to as "one of the most remarkable ever obtained from the mounds." "There can be little doubt," says Professor Holmes, "that the figures of this design are derived from the mythologic art of the people."

Vessels Nos. 18, 19, 20.—These vessels, respectively, a small bowl with beaded margin; a broad-mouthed water-bottle with incised decoration showing five open hands pointing downward, on each of which is an open eye (Fig. 153); and a pot with four loop-handles, each bearing three small protuberances (Fig. 154), were present together under the chest of a skeleton. As there had been much disturb-

[1] *Op. cit.*, p. 91.

FIG. 151.—Vessel No. 17. Ridge north of Mound R. (Height 6 inches.)

ance in the pit in which these vessels were, and as disturbed skeletons (of children) were near at hand, it is possible that these vessels, originally placed at the head of a skeleton, owed their final position to the general disturbance that had prevailed in the pit. Vessel No. 20, which had a small perforation somewhat above the base, was found among roots of a tree, and had sustained a fracture of the rim through their agency. Presumably the perforation on the side is traceable to the same cause.

FIG. 152.—Vessel No. 17. Decoration. Ridge north of Mound R. (About half size.)

FIG. 153.—Vessel No. 19. Ridge north of Mound R. (Diameter 3.5 inches.)

FIG. 154.—Vessel No. 20. Ridge north of Mound R. (Diameter 6 inches.)

FIG. 155.—Vessel No. 23. Ridge north of Mound R. (Diameter 6.75 inches.)

FIG. 156.—Vessel No. 24. Ridge north of Mound R. (Diameter 4.25 inches.)

Vessel No. 21, a wide-mouthed water-bottle with depressions and scroll decoration, lay near the skull of Burial No. 33, with other objects to be described later.

Vessel No. 22, an undecorated, broad-mouthed water-bottle, lay near the scattered bones of a child.

Vessel No. 23, a pot found in fragments, having notched decoration around the rim and two loop-handles (Fig. 155). There have been four equidistant projections on the body of the vessel, one of which belongs on a part not recovered by us. The ware of this vessel, black and polished, is superior to that usually found in Moundville vessels of its shape.

Vessel No. 24, a broad-mouthed water-bottle with two incised designs representing four conventionalized tails of wood-peckers, in pairs (Fig. 156).

Vessel No. 25, an undecorated vessel, hopelessly crushed.

Vessel No. 26, a wide-mouthed water-bottle (Fig. 157), bearing the incised meander shown in diagram in Fig. 158.

Vessel No. 27, an interesting water-bottle, of which a part only was recovered; the remainder has been restored. The decoration, on the original part of the vessel, consisting of down-turned hands in low relief, is shown in diagram in Fig. 159.

Vessel No. 28, an undecorated bowl found lying, as usual, near a skull.

Vessel No. 29, a small, rude pot of coarse ware, having a loop-handle on one side and the remains of one on the other, found apart from human remains.

FIG. 157.—Vessel No. 26. Ridge north of Mound R. (Diameter 5.25 inches.)

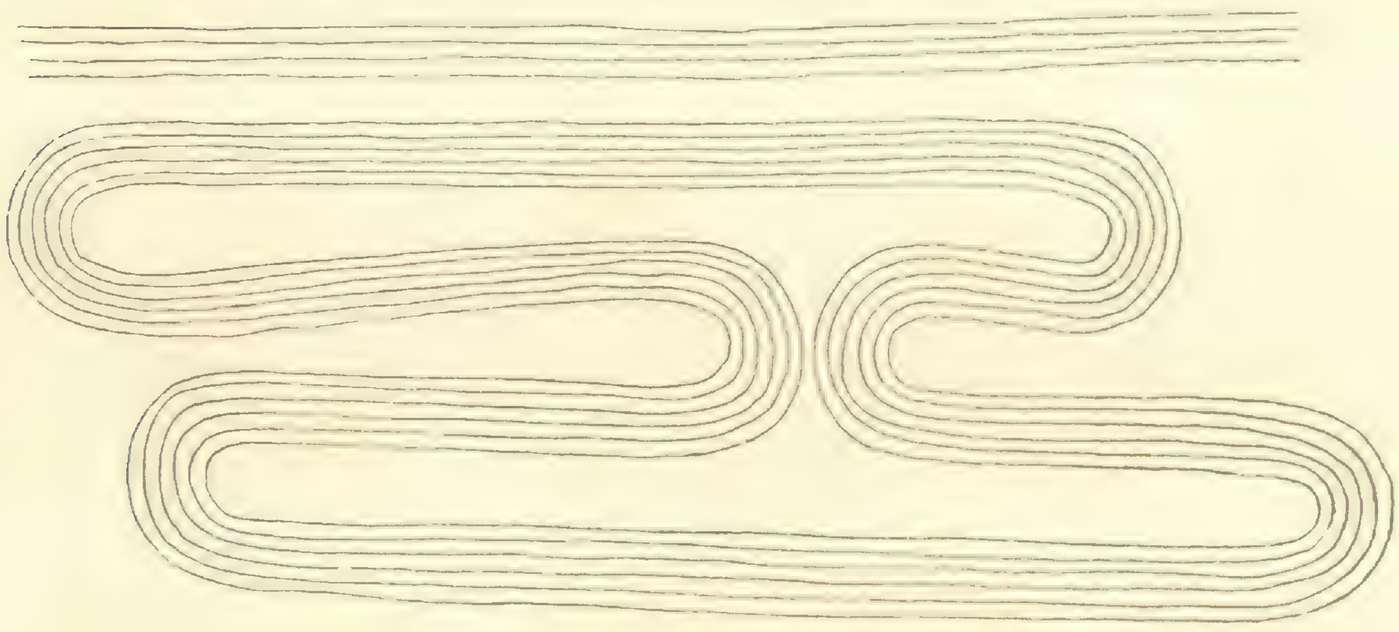


FIG. 158.—Vessel No. 26. Decoration. Ridge north of Mound R. (About half size.)

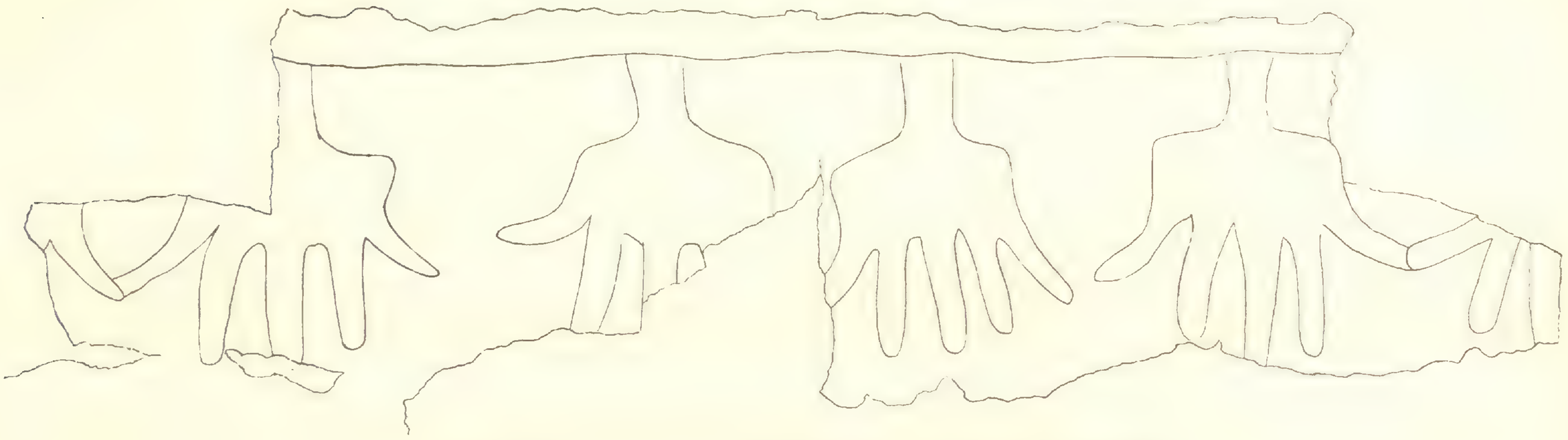


FIG. 159.—Vessel No. 27. Decoration. Ridge north of Mound R. (About half size.)

Vessel No. 30 consists of the lower part of a water-bottle, found in a pit near disturbed human remains (Fig. 160). The decoration, which is most interesting, represents the head, tail and wings of an antlered and winged rattlesnake, as shown in diagram in Fig. 161. With this vessel was part of an undecorated bowl.

Vessel No. 31, exact details as to the finding of which are not in our field notes, is a broad-mouthed water-bottle with the incised meander decoration shown in Fig. 162.

With the exception of earthenware, but few objects had been deposited with the dead in this low mound; but such as were placed there fully made up in quality for the deficiency in number.

In the outskirts of the mound lay a skeleton extended on the back, having near the skull part of a polished "celt" and a very rude maul, probably of diorite,

FIG. 160.—Vessel No. 30. Ridge north of Mound R. (Diameter 5 inches.)

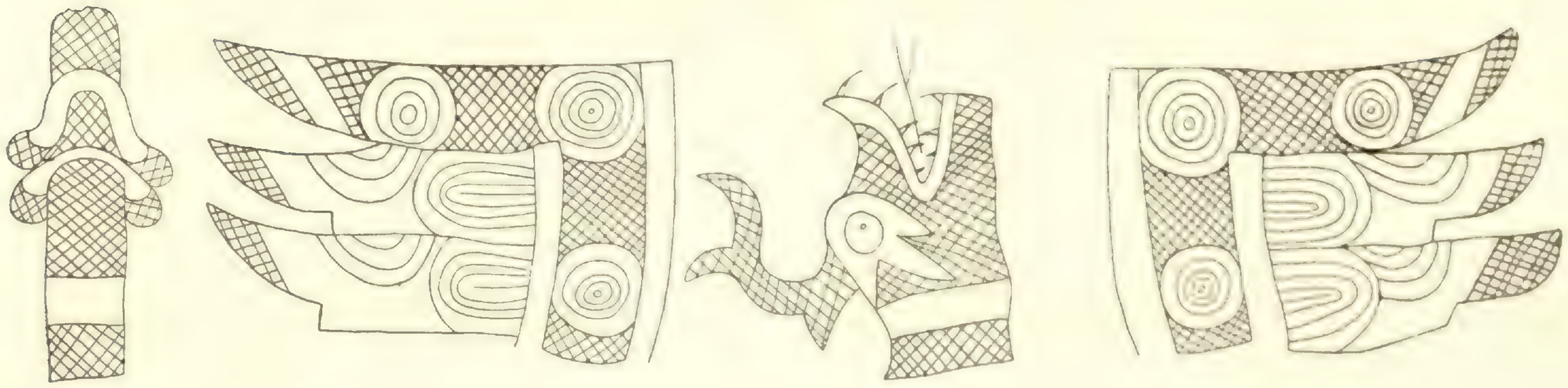


FIG. 161.—Vessel No. 30. Decoration. Ridge north of Mound R. (About half size.)

13 inches in length, shattered by blows at one end, having a shallow, encircling groove, where it had been fastened to a handle, somewhat more than half-way above the heavier end.

With bits of femur and fragments of other decaying bones was a rude, undecorated smoking-pipe of coarse ware and of ordinary type.

In a grave-pit was a skeleton at full length on the back, above disturbed bones of a child. Near these remains were shell beads, a shell gorget having a cross within a circle and a scalloped margin on one side (Fig. 163), and fragments of sheet-copper. On the vertex of the skull of the adult were two beads of wood overlaid

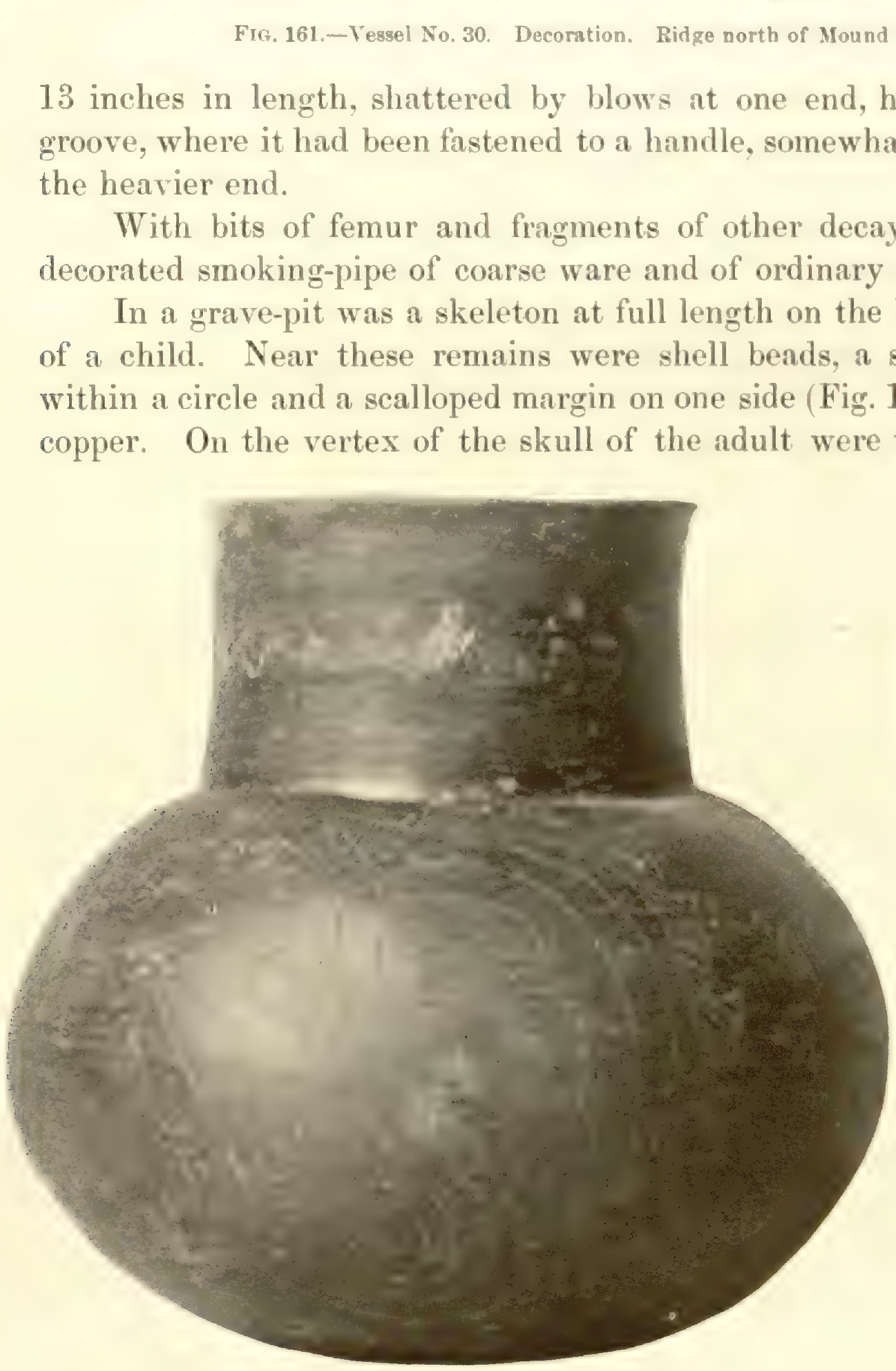


FIG. 162.—Vessel No. 31. Ridge north of Mound R. (Height 5.75 inches.)

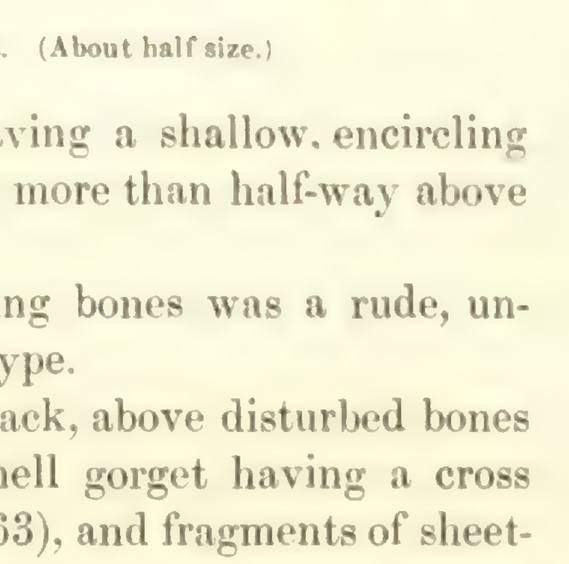


FIG. 163.—Shell gorget. Ridge north of Mound R. (Full size.)

FIG. 164.—Copper fish-hook. Ridge north of Mound R. (Full size.)

FIG. 165.—Effigy-pipe of limestone. Ridge north of Mound R. (Full size.)

FIG. 166.—Effigy-pipe of limestone. Side view. Ridge north of Mound R. (Length 5.75 inches.)

FIG. 167.—Stone vessel. Ridge north of Mound R. (About half size.)

with sheet-copper, each somewhat less than an inch in diameter. Part of the skull is stained green from contact with the metal. Nearby, in the soil, was a copper fish-hook (Fig. 164), unbarbed, but grooved to receive a line. We believe this to be the only fish-hook of copper ever discovered in southern United States.

Directly under the head of a disturbed skeleton was a disc of fine-grained gneiss, 5.5 inches in diameter, with notched margin, and having a trace of white paint on one side and a quantity of red pigment on the other. With the disc were twelve spherical shell beads each about .6 of an inch in diameter.

FIG. 168.—Stone vessel. Duck's head, side view. (Slightly under full size.)

On the chest of a partly disturbed skeleton were fragments of a shell gorget.

In a pit, 17 inches from the surface, were the remains of a skeleton of an adult, on its back, the part extending from about half-way down the trunk having been

FIG. 169.—Stone vessel. Duck's head, front view. (Slightly under full size.)

cut off in making space for another interment. At the skull were Vessel No. 21, also parts of an undecorated vessel, and bits of sheet-copper and shell beads. With these, immediately against the skull, was an effigy-pipe of limestone, or possibly

phosphate rock, doubtless representing a panther, since neither the wolf nor the bear, the only other large carnivores frequenting the neighborhood of Moundville in the past, assumes the crouching position shown by the effigy. This pipe, shown in two positions (Figs. 165, 166), is 4.2 inches in height and 5.75 inches from end of snout to tip of tail. Traces of carbonized tobacco or of some other herb, remain in the bowl.

Alongside this pipe and projecting beyond it, was what seemed to be a sharp fragment of stone. This fragment, when taken from its position, proved to be part of the rim of a large bowl, from which projected upward a beautifully-carved arching neck and head of a crested duck, evidently the drake of the woodduck. Part of the crest is missing. Some distance away, in the same pit, lying on its side just below the surface of the ground, as if it had been removed at the time the skeleton, with which part of it remained, was cut off, was the rest of the bowl to which the duck-head belonged. On the side of the bowl opposite the head is the conventional tail usually found on vessels of earthenware on which a head is represented. The vessel, the parts of which have been reunited, is 11.5 inches in maximum height. The height of the bowl proper is 6.8 inches; its diameter is 11.75 inches. The thickness of the rim, which varies slightly, ranges between .25 and .3 of one inch. On the head and neck of the duck, on the conventional tail and on the body of the vessel, is incised decoration executed with wonderful accuracy, all things being considered. This triumph of aboriginal endeavor, the "Portland vase" of prehistoric art in the United States, is shown in Fig. 167; the head of the duck is represented in three positions in Figs. 168, 169, 170; the decoration on the back of the neck and head is shown in diagram in Fig. 171.

The missing part of the crest of the duck was vainly sought by five men, who, for several hours, passed between their fingers all material that had been thrown from the excavation—the clayey nature of the soil unfortunately precluding the use of sieves. Presumably the blow that broke the head from the rest of the bowl, struck the crest also, shivering parts to small fragments.

When this vessel was found we knew it to be the result of much labor, although we supposed it to be of soft stone—slate presumably. Examination, however, showed the material to be of far greater hardness than characterizes slate. Naturally, the vessel has not been mutilated for exact determination of its material, which, however, probably has been arrived at with a reasonable degree of certainty. We have referred to a maul found in the low mound from which this vessel came. Not far away, a member of our party picked up a fragment of what had been a polished bowl of stone of about the thickness of the duck-bowl, and, as indicated by its curvature, probably of about the same size. This fragment, a part of the maul, and the vessel found by us, were submitted to Dr. E. Goldsmith, who, by minor tests, decided that all three were of the same stone, and named the group from which they came.

Complete quantitative analyses by Dr. H. F. Keller, of part of the maul and of a portion of the fragment of the stone vessel showed them to be practically of the

FIG. 170.—Stone vessel. Duck's head, back view. (About full size.)

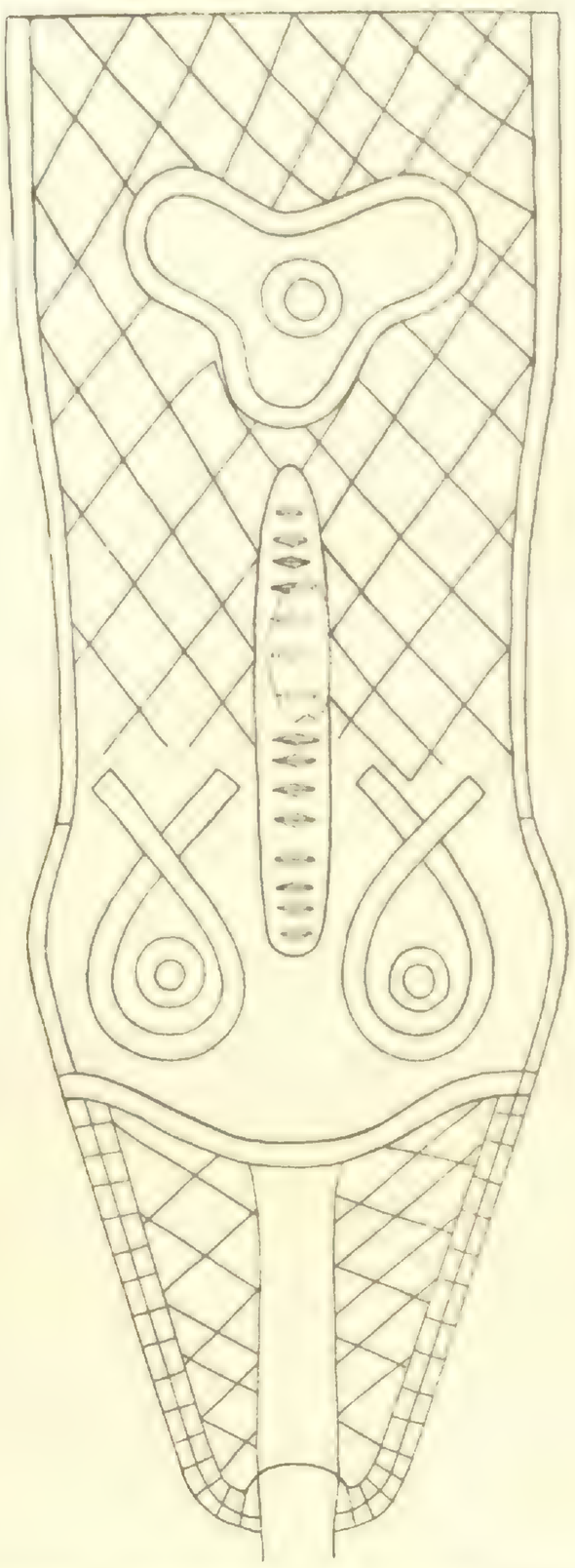


FIG. 171.—Stone vessel. Decoration on head and neck of duck. (About half size.)

same kind of stone. The results of these analyses, and two slides for the microscope, one made from each of the same two specimens, were submitted to Prof. George P. Merrill, Head Curator of Geology, United States National Museum, who kindly had consented to investigate the matter. Professor Merrill writes:

"I find on examination that the rock is so highly altered that its original mineral composition cannot be determined with any degree of accuracy.

"From examination of the structure, so far as it has been preserved during the

process of alteration, and a consideration of the chemical composition, as given in your analyses, I am inclined to regard the stone as a diorite. This, however, must be accepted with a certain amount of allowance, for the reasons before stated."

With a reasonable degree of certainty, then, we can pronounce the vessel from the low mound north of Mound R to be of diorite, a rock so hard that the making of the bowl by aboriginal methods must have been a task indeed.

We are indebted to Mr. James A. Anderson, whose kindness we have acknowledged before in this report, for a geological map of Alabama, made by Prof. E. A. Smith, State Geologist. It is seen by this map that the middle eastern part of the State is, geologically, of igneous and metamorphic rocks, so that the vessel or the material to make it, as the case may be, had, of necessity, no great distance to come.

Field West of Mound R.

Immediately west of Mound R is a cultivated field having considerable slope in places. A tree of recent growth in this field has some of its roots about a foot above the present surrounding level, thus showing what destruction to cemeteries prolonged cultivation must have wrought at Moundville.

Considerable digging was done in this field, and several burials were met with in addition to a number of disturbed bones.

A skeleton at full length on the back, lying just below the surface, had, at the

Fig. 172.—Vessel No. 1. Field west of Mound R. (Diameter 5 inches.)

Fig. 173.—Vessel No. 2. Field west of Mound R. (Diameter 3.75 inches.)

knees, a smoking-pipe of coarse ware and fragments of a rude pot with an arrow-head of jasper nearby. Under the legs were several small fragments of sheet-copper. At the feet were 103 pebbles and parts of pebbles, all or nearly all of jasper. With these were six small arrowheads of jasper, more or less rudely made, and one drill of the same material. At the left knee was Vessel No. 1, a rude water-bottle of coarse, yellow ware, with three large, hollow feet (Fig. 172). Part of the body of this vessel, which had been carried away by the plough, has been restored. At the skull was Vessel No. 2 (Fig. 173), which, by an unfortunate blow from a plough, has lost its upper part. The decoration is a repetition of the open hand with the open eye upon it.

A handsome piercing implement of bone, 6 inches long, highly polished, with three notches at each of two sides of the blunt end, lay apart from human remains.

A full-length skeleton, on the back, had at the neck a quantity of beads made from portions cut from thick parts of mussel-shells, where the muscular attachment is. These nacreous beads must have presented an attractive appearance in their time.

A skeleton, also at full length, whose interment had cut through another skeleton, had shell beads at the wrist.

A small, thin disc of limonite, with many scratches on each side, and a small stone chisel with double cutting edge, lay apart from human remains.

Mound S.

Mound S, a small remnant of what once was an inconsiderable mound within the line of encircling mounds, was dug into by us with no material result.

Mound T.

Mound T, apparently another small remnant within the circle, was thoroughly dug into by us with no result except the discovery of part of a disturbed skeleton just under the surface.

Here ends the account in detail of our digging at Moundville. Let us now consider the question of domiciliary mounds. In much of our work at Moundville, and all along the Black Warrior river, for that matter, we have assumed that large mounds with flat summit plateaus were built by the aborigines for purposes other than that of sepulture. Now let us see on what grounds this assumption was based. As we have to do with southern mounds, we need go no farther for data than our own field of exploration in the South.

The mound on Little Island,[1] South Carolina, elliptical in outline, 11 feet to 14 feet in height, was about 100 feet by 150 feet in basal diameter. The summit plateau was 38 feet by 61 feet. An excavation in the central part of the mound, about 45 feet by 55 feet, to the base, was made by us. One superficial burial was met with, and also the bones of an infant under a house of clay and wattle, which

[1] "Certain Aboriginal Mounds of the Coast of South Carolina," Journ. Acad. Nat. Sci. of Phila., Vol. XI.

was found on the base of the mound. Evidently this mound was not built for burial purposes.

On St. Helena Island, South Carolina, is a mound, about 13 feet in height, known as Indian Hill. In shape it is approximately a truncated cone with basal diameters of 138 and 129 feet. The summit plateau, about circular, is 62 feet across. A trench 18 feet wide at first, later contracted to 15 feet, was dug along the base to its central part. Four distinct stages of occupancy were met with, but no burials.

The Shields mound,[1] near the mouth of St. Johns river, Florida, has a height of 18 feet. Its base, excluding a graded way, is about 214 feet square. Its summit plateau is 115 feet by 133 feet.

Excavations around the base of this mound yielded burials that appeared to have been rather recent, and having no artifacts with them.

Next the entire eastern slope of the mound was dug away, and, in addition, 10 feet of the eastern end of the body of the mound, under the summit plateau. This digging, which was done along the base of the mound, was extended inward 27 feet in a trench 175 feet broad. Then the trench, reduced to a breadth of 115 feet, was carried in 21 feet farther. The mound showed various periods of occupancy but no burials were found at a depth of more than 3 feet from the surface.

Next, all that remained of the summit plateau was dug through at a depth of from 6 to 8 feet. Human remains, reduced almost to dust in many cases, were found in abundance, all within 4 feet of the surface, with four exceptions, which were 6 feet down. Here we have a domiciliary mound with superficial burials.

Near St. Johns Landing,[2] on St. Johns river, was a mound, circular in outline, 7.5 feet in height. Its basal diameter was 95 feet; its summit plateau was 60 feet across. Twenty-one men, working five days, levelled it to the base. With the exception of two burials near the surface, no human remains were met with. Assuredly, this mound was not intended for burial purposes.

Near Walton's Camp,[3] Santa Rosa county, Florida, is a mound about 12 feet in height. The basal diameters are 178 feet by 223 feet; those of the summit plateau, 135 feet by 179 feet. A great amount of digging in this mound showed it to have been used as a place of domicile and to have been heightened and increased in extent at different periods. Only superficial burials were found in it.

It was on account of the results obtained in the foregoing mounds, and in a number of others not particularly noted here, that we assumed the mounds of Moundville, on account of their size and shape, to have been built for a purpose, or for purposes, other than those of burial, a conclusion, we think, borne out by the result of our work in Mound C and in Mound L. Of course, it is possible that certain of the mounds there were built by stages, and that burials were made from the

[1] "Certain River Mounds of Duval County, Florida," Journ. Acad. Nat. Sci. of Phila., Vol. X.

[2] "Certain Sand Mounds of the St. Johns River, Florida," Part II, Journ. Acad. Nat. Sci. of Phila., Vol. X.

[3] "Certain Aboriginal Remains of the Northwest Florida Coast," Part I, Journ. Acad. Nat. Sci. of Phila., Vol. XI.

various levels of occupancy, as was shown to have occurred in Mound C. But even if such were the case, and to determine this would be a stupendous work, the character of the mounds would remain the same.

Mound in Moundville, Hale County.

In the town of Moundville, in front of the dwelling of Mr. J. A. Elliott, in pine woods, is a much-spread, circular mound of sand, about 3 feet in height. Thirteen trial-holes produced no positive result.

Mound Near McCowin's Bluff, Tuscaloosa County.

This mound, about 9 feet in height, in sight from the river, has been oblong, but at present its corners and sides have been greatly rounded by cultivation. We were unable to obtain permission to investigate this mound; however, a small excavation, made by us in the central part of the plateau, showed the mound, at that place, to be of hard clay and very unlike domiciliary mounds in which burials have been made.

Mound near R. H. Foster Landing, Tuscaloosa County.

At this landing is a plantation, belonging to Miss Florence H. Foster, of Sylvan, Alabama, on which is a mound almost obliterated by cultivation. That which remains was dug into at a number of places by us, but no sign of human bones or of artifacts was encountered.

Parts of surrounding fields show traces of aboriginal occupancy. Though many holes were dug by us to undisturbed soil, but one burial pit was revealed. In this grave-pit were two skeletons at full length lying on their backs, one 2 feet below the surface, the other 3 feet. No artifacts were with them.

Mound near Jones' Ferry Landing, Tuscaloosa County.

This mound, about one mile in a northerly direction from the landing, in a cultivated field not far from the water, had been largely ploughed away. Fragments of pottery and a human tooth lay on the surface. As the field from which the mound rises is subject to overflow and consequent wash, no excavation was permitted.

Mound near Hill's Gin Landing, Tuscaloosa County.

This mound, in a northerly direction from the landing, near the river, on property of Dr. T. M. Leatherwood, of Tuscaloosa, is 6 feet 8 inches high. Its length east and west is 133 feet; its breadth north and south is 100 feet. Its summit plateau is 91 feet by 69 feet in corresponding directions. Thirteen trial-holes yielded neither human bone nor artifact.

Cemetery below Foster's Ferry Landbridge, Tuscaloosa County.

Reports are current that human bones have been found at this place in the cultivation of the fields, and that vessels of earthenware have been laid bare by freshets. Certain vessels in the Museum of the University of Alabama, near Tuscaloosa, are marked as having come from Foster's Ferry, but we are informed by Mr. Anderson, who is greatly interested in archæology, that the vessels were obtained long ago and that data as to the exact locality whence they came are wanting. Considerable digging was done by us at this place, in spots pointed out by residents as having furnished evidence in the past of being places of burial, but neither bones nor artifacts were met with by us. Presumably former graves had been ploughed through or washed away by freshets. There is a remnant of a mound on the river bank.

Cemetery above Foster's Ferry Landbridge, Tuscaloosa County.

A short distance above the landbridge, on the eastern side of the river, is a plantation where, it is said, aboriginal ware has been found and where our agent, when locating mounds, saw much broken pottery on the surface. We were not permitted to dig here, the owner fearing ill effect from loosened ground at the coming of another freshet.

There are other localities along the Black Warrior river below Tuscaloosa, where the finding of aboriginal earthenware has been reported, but permission to dig was not forthcoming, the owners fearing injury to the property in flood-time.

The reader will note that along the Black Warrior river, between its junction with the Tombigbee, and Tuscaloosa, no burial mound was met with by us. All aboriginal interments were in graves. The occasional use of the summit plateau of a domiciliary mound as a cemetery by the aborigines, forms no exception to this rule.

MAP OF TOMBIGBEE RIVER TO REMBERT'S LANDING

Reduced from Government Survey

Scale in miles

0 5 10

1905

X indicates mound

CERTAIN ABORIGINAL REMAINS OF THE LOWER TOMBIGBEE RIVER.

By Clarence B. Moore.

As the reader is aware, the Tombigbee and Alabama rivers unite to form the Mobile river about forty-five miles, by water, above the city of Mobile, Alabama.

The Mobile river and the Alabama were investigated by us during the season of 1899.[1]

During the summer of 1900, Mr. J. S. Raybon, captain of the steamer from which our mound work is done, started with a companion at Columbus, Miss., the present head of navigation, and continued down the little Tombigbee river, as the upper part of the Tombigbee before its union with the Black Warrior, near Demopolis, is sometimes called, and down the Tombigbee river to its junction with the Alabama. In this way were located a great number of mounds, the owners of which almost unanimously accorded us permission to dig.

Part of the winter of 1901 was devoted by us to a careful examination of the Little Tombigbee river between Columbus, Miss., and Demopolis, Ala., 149 miles by water. In addition, the upper 29 miles of the Tombigbee river, from Demopolis to Bickley's Landing, were investigated.[2] This left unexplored by us 156 miles by water between Bickley's Landing and the junction of the Tombigbee with the Alabama. It is with these 156 miles that this account of part of our work of the season of 1905 has to do. Instead of going downstream, however, as we did in 1901, this season we went up the Tombigbee to the place where our work had ended before.

The warm thanks of the Academy are tendered all owners of mounds and camp sites on the Tombigbee river, who so courteously placed their property at its disposal.

Mounds and Camp Sites Investigated.

Mound near the Cut-off, Clarke County.
Mound at Hooks' Plantation, Clarke County.
Mounds at Three Rivers Landing, Washington County (4).
Mound at Payne's Woodyard, Clarke County.
Mound near Carney's Bluff, Clarke County (2).
Mound near Gaines' Landing, Washington County.
Mound near Bolan's Woodyard, Washington County.

[1] "Certain Aboriginal Remains of the Alabama River," Journ. Acad. Nat. Sci. of Phila., Vol. XI.
[2] "Certain Aboriginal Remains of the Tombigbee River," Journ. Acad. Nat. Sci. of Phila., Vol. XI.

Mounds near Jackson, Clarke County (2).
Mounds at Jackson Landing, Clarke County (2).
Mound in Kimbell's Field, Clarke County.
Mound opposite Peavey's Landing, Washington County.
Mound near Santa Bogue creek, Washington County.
Mound near Malone's Gin, Clarke County.
Mound near Bass' Landing, Choctaw County.
Mound at Cox's Landing, Clarke County.
Dwelling Site at Thornton's Upper Landing, Clarke County.
Mound near Powe's Landing, Choctaw County.
Mound near Noble's Gin, Clarke County.
Mound below Bashi creek, Clarke County.
Mound near Bashi creek, Clarke County.
Mound on the Watters' Plantation, Marengo County.
Mound below Horse creek, Marengo County.
Mounds below Beaver creek, Marengo County (4).
Mounds near mouth of Beaver creek, Marengo County (14).
Mounds near Breckenridge Landing, Marengo County (40 to 50).
Mounds near Steiner's Landing, Choctaw County (3).
Mounds near Rembert's Landing, Marengo County (31).

Mound near the Cut-off, Clarke County.

The Cut-off is a narrow water-way between the Alabama and Tombigbee rivers, eight miles by water above their junction. The mound, on property belonging to Mr. C. G. Foote, of Calvert, Alabama, is in thick swamp, about 150 yards from the southern side of the Cut-off, and approximately three-quarters of a mile from the Tombigbee river. The mound is composed of a mixture of clay, sand, and loam. Its height is 5 feet 4 inches; its basal diameter, 62 feet. As it was not deemed advisable to destroy this mound, owing to its use as a place of refuge by cattle in times of high water, thirteen excavations, each about 3 feet square, were made in it to the base.

In one excavation was a small bunched burial consisting of a skull with its lower jaw, one clavicle, one bit of pelvis, one scapula, three cervical vertebræ, and several foot-bones.

Nine inches from the surface was a small layer of fragments of calcined, human bones, including parts of a skull. Directly beneath this layer was a pile of unburnt bones, with two crania, accompanying which was a hone of ferruginous sandstone. Dissociated in this mound were a few pot-sherds, one shell-tempered, several without shell-tempering. Certain sherds, of excellent ware, bore incised decoration.

Mound on Hooks' Plantation, Clarke County.

Hooks' plantation, the property of Mr. A. F. Hooks, of McIntosh Bluff, Ala., is about two miles above McIntosh Landing, but on the eastern side of the river.

The mound, which resembles a natural ridge and probably was an elevation made by wash of water in flood-time, to which, perhaps, an amount of sandy clay had been added at one end by the aborigines, is in the swamp about one hundred yards in a southeasterly direction from the landing. No measurements were taken, as we found it impossible to distinguish between the artificial and the natural, but 2 feet closely approximates the maximum height. As this mound serves as a refuge for cattle during high water, it was not completely leveled, though a large part of it was dug through.

Fourteen inches down was a skull in fragments, like all others found in the mound. Near it were two bits of bone.

Beginning one foot from the surface was a layer of bones, of irregular outline, 20 inches by 30 inches in maximum diameters, including four skulls, one belonging to a child. The average thickness of this layer was somewhat less than that of the skulls it contained.

Near the deposit just described was a bunched burial, including one skull.

Fragments of a long-bone lay about 8 inches below the surface.

Six inches down was the lower part of a bowl of inferior ware, in fragments, resting on its base. This remaining part had a depth of eight inches. On the bottom lay an astragalus of an adult. Above this bone was a pile of fragments representing part of another vessel. Presumably the ground had been under cultivation in former times, and all these fragments were remains of an enclosing bowl and its surmounting, inverted vessel. In all probability most of the bones included in this urn-burial had been carried away by the plough which broke the vessels.

In another part of the mound was the base of a large bowl, probably all that remained of an urn-burial.

Ten inches from the surface was a flat mass of hematite, about the size of a fist, in a small pocket of charcoal. Several nails and one spike of iron lay together apart from the interments.

With the smaller bunched burial, to which reference has been made, were glass beads. With the larger burials were glass beads; four beads of sheet-copper or sheet-brass, corroded through and through; an object of glass resembling the stem of a wine-glass with the base broken away; and four Romanist medals of saints, certain of which had been wrapped in matting, parts of which remained. Three of these medals had "eyes," or small, circular attachments for suspension. The "eye" belonging to the fourth medal, broken off, had been substituted by a small hole. The unappreciative savage, however, had placed this hole at the lower side of the medal, so that the saints hung upside down when the medal was suspended.

Mounds near Three Rivers Landing, Washington County.

These mounds, four in number, in sight one of another, on property of Mr. James B. Slade, of Slade's, Alabama, are about two hundred yards in a SSW. direction from the landing. It is said positively that these mounds, in common with the surrounding territory, have been under cultivation in the past, a report borne out by their extended appearance.

The northernmost mound, of clear, yellow sand, yielded no return save half a "banner-stone" wrought from a clayey material. Two holes show where the parts of the ornament had been lashed together with the aid of similar perforations in the missing half.

The second mound, 18 inches high and 35 feet in basal diameter, seemed to have been built for domiciliary purposes. It was composed of sandy loam, almost black, having a sprinkling of shells, mostly broken, one kind being a fresh-water mussel (*Quadrula trapezoides*). Certain of the shells are calcined. The dark sand, discolored by admixture of organic matter, was found to a depth of 30 inches, or one foot more than the height of the mound. This does not imply, however, that work had been done by the aborigines below the original surface of the ground, but rather that sand and leaf-mould had gathered on the general level around the mound after its completion, thus lessening its height. This domiciliary mound, with its blackened earth, shells, deer-bones, and other debris, had in one part a local layer of clear, yellow sand, which had been cut through, here and there, for burials placed below it. The mound, then, had been used as a burial mound after its completion or during the last stage of its occupancy. The mound was completely leveled by us.

Apart from human remains, were: hammer-stones; pebble-hammers; pebbles, whole and broken; hones of ferruginous sandstone; several tines of staghorn; a canine tooth of a large carnivore; part of a bone needle with an eye; a number of broken arrowheads or knives; eight lanceheads, arrowheads, and knives, three of chert, five of quartzite, some variegated; various fragments of earthenware, some shell-tempered, others not, none showing any novelty in design.

Two feet nine inches down, apart from human remains, was an interesting deposit of eight leaf-shaped implements of quartzite, each about 2.5 inches and 4.5 inches in maximum diameters, neatly piled one upon another.

While the burials in this mound were not marginal, neither were they entirely central, though all may be said to have been in the body of the mound. The condition of the bones, while far from good, was better than is the case in many mounds, owing, perhaps, to infiltration of lime salts from the shells. Two skulls with their mandibles were saved in fair condition. Each shows marks of cranial compression on the frontal part, as did each skull in this mound, not too badly crushed to allow determination. One of the two skulls, that of an adolescent, showed, in addition to the effect of frontal compression, a longitudinal groove along the middle line of the skull. The two crania, the only ones found by us in a condition to preserve during our entire season's work, were sent by us to the United States National Museum at Washington.

Eighteen inches from the surface, below a space cut through the local layer of sand, of which mention has been made, was a bunched burial consisting of bones of an adult and of a child.

Fifteen inches below the surface lay a bunched burial with one cranium, and, at about the same depth, some distance away, was a bunch of bones with two crania. With the latter burial were a number of glass beads.

A skeleton at full length on the back lay 1 foot 10 inches from the surface. The cranium was one of the two to which reference has been made.

In a grave 3 feet 5 inches deep, made by cutting through the local layer of yellow sand, and extending below the base of the mound, lay a skeleton at full length on the back, in anatomical order up to the upper dorsal region. The uppermost dorsal, and the cervical, vertebræ were in disorder. Just beyond them were the right clavicle and the manubrium. The skull, the left clavicle, both scapulæ, and both humeri were missing. The radii and ulnæ and all the finger bones were in place, as were most of the ribs. The head and neck of the right femur and the corresponding acetabulum, which showed a pathological condition, have been sent by us to the Army Medical Museum at Washington.

Two feet six inches from the surface was a skeleton at full length on the back, having all bones present except the calvarium. The atlas was turned over backward, as if disturbed by the removal of part of the skull.

The skeleton of a child, flexed on the right side, lay 2 feet 2 inches from the surface.

The skeletons of two children, side by side, each flexed on the left side, lay 2 feet 3 inches down.

In a grave which had been cut through the local layer of yellow sand, 20 inches from the surface, was the skeleton of a child, partly flexed on the left side.

About the same depth in another part of the mound was the complete skeleton of an adult, lying at full length on the back.

A skeleton, also at full length on the back, had a skull showing marked frontal flattening, one of the two sent to the Army Medical Museum.

There were also in this mound: a bunched burial with one skull; a lone calvarium; part of a skeleton without a cranium, parts in order, others not; the skeleton of an adolescent, in order to the lumbar region but disarranged above.

But a few inches below the surface was the body of a large bowl, of coarse, shell-tempered ware, with rough, incised and punctate decoration. In this large fragment, from which the rim was entirely missing, were ten human vertebræ, a sternum, one clavicle, one scapula, and certain ribs. Obviously the upper part of this bowl had been wrecked by contact with a plough, and possibly, at the same time, an inverted bowl, serving as a cover, and perhaps some of the bones, may have been carried away. We have found numerous urn-burials in this condition in Georgia and along the Alabama river.

Thirty inches from the surface lay a skeleton at full length on the back. The left arm was parallel with the body; the right forearm was flexed upward, the hand resting on the shoulder. The skull lay on its vertex, the face turned from the rest of the skeleton. Three cervical vertebræ lay beside the skull; the mandible and one clavicle lay a little beyond it. Presumably in removing the skeleton from the dead-house after the flesh had decayed, the skeleton being held together by ligaments, the skull and certain neighboring parts had become detached and had been carelessly replaced. Near the neck were many glass beads and two barrel-shaped ones

of shell. By the skull were two neatly-made shell hair-pins, more pointed than is usually the case. Inverted on the base of the skull, covering but part of it, like a cap, as shown in Fig. 1, was an imperforate bowl of common shell-tempered ware, undecorated save for four small, equidistant projections at the rim. The measurements[1] of this bowl are: maximum diameter, 6.5 inches; diameter of opening, 5.5 inches; height, 4 inches.

In a recent paper[2] mention was made of what might be called a form of urn-burial that had been noted in New Mexico and Arizona, where the skull, lying with its skeleton, was covered by an inverted bowl. In the early part of the present

FIG. 1.—Burial. Mound near Three Rivers Landing.

season (1905) we found in a mound to the north of Mobile bay, Alabama, just such a burial, the skull being entirely covered by a curiously decorated bowl. Unfortunately we found no repetition of this form of burial either on Mobile bay or on Mississippi sound, as may be noted in the report which follows this one. This discovery, on the Tombigbee river, of a bowl inverted on a skull, though not covering it, may be regarded as additional evidence that the custom of placing bowls over skulls[3] with their skeletons, occasionally was practised farther east than has hitherto been reported.

The third mound in order, on the edge of the bluff, originally circular in outline, had a small part washed away. Its height was 2 feet 2 inches; the basal

[1] All measurements of earthenware in this report are approximate only.

[2] "Aboriginal Urn-burial in the United States," by Clarence B. Moore, American Anthropologist, Oct.–Dec., 1904.

[3] The reader will not confuse this custom with a well-known form of urn-burial practised along the northwestern Florida coast, where inverted bowls were placed over isolated skulls or skulls accompanied by a few bones only.

diameter, 50 feet. More than three-quarters of the original area of the mound were dug away by us, little being left but portions around two large trees. The material was sand with admixture of loam. Signs of former use as a place of abode were wanting.

Apart from human remains, together, were sixteen pebbles or parts of pebbles, a hone, and near these a lump of hematite. Elsewhere in the mound, away from burials, were: a circular stone, about 4 inches in diameter, pitted on each side; a mass of ferruginous sandstone, which probably had been used as a hammer; four arrowheads or knives, some of chert, some of quartzite; a sharp flake of chert; several pebbles; a few bits of earthenware.

Human remains in this mound were badly decayed. There were present in the mound what was left of twenty-two crania, exclusive of those of children. Three of these showed frontal compression and six did not. Thirteen skulls were too badly decayed to allow determination. One of the skulls with anterior flattening had, in addition, a longitudinal groove of the kind noted in the preceding mound.

As exact description of all burials in this mound would be wearisome to the reader, only those of especial interest will be noted in detail. There were present in the mound burials in fourteen places.

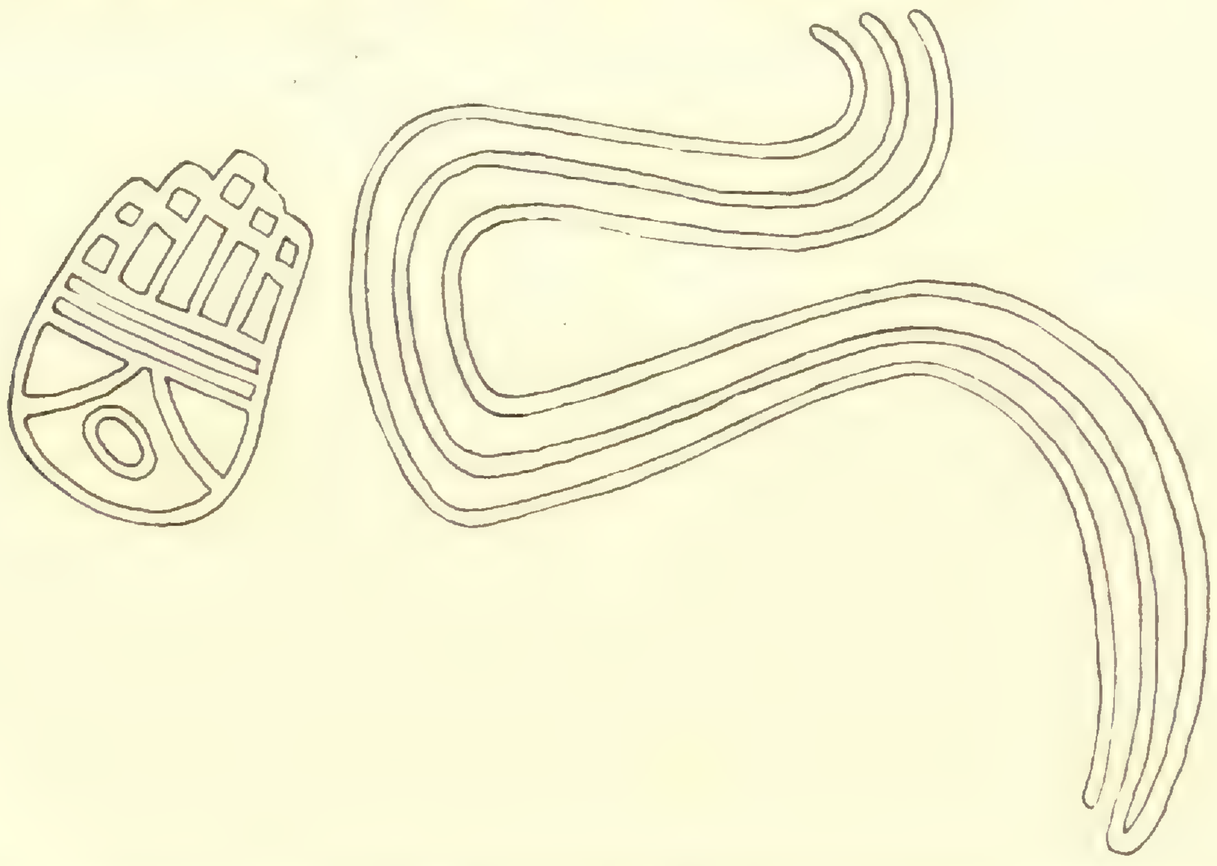


FIG. 2.—Decoration on part of vessel. Mound near Three Rivers Landing. (About half size.)

Seven inches down was a large pile of long-bones carefully placed parallel one to another. This pile, which represented several individuals, possibly five or six, slanted upward somewhat. Farther in the mound, in contact with the pile, were one skull, a pelvis, vertebræ, ribs, and a few other bones. On and above the upper part of the mass of long-bones were many fragments of what seemingly had been part of a large vessel of ware shell-tempered in places as if the powdered shell had been unevenly distributed. But little of the rim remained. The decoration, incised, probably consisted of a repetition of two symbols, one being a paw or perhaps an open hand (Fig. 2), and the other a leg.

Thirteen inches from the surface was another bundle of parallel long-bones, consisting of seven humeri, six radii, six ulnæ, seven femurs, seven tibiæ, and four fibulæ. At one end of this pile were the bones of an infant.

With its rim 8 inches below the surface, resting on its base, in which there is a mortuary perforation, was a bowl of inferior, shell-tempered ware, without decoration, except certain projections from the rim. The maximum diameter of the vessel is 12.5 inches; its height, 8.5 inches. In the sand which filled this vessel was part of the skull of a young infant. Here we have an urn-burial without a covering vessel, for, presumably, had a plough struck an upper vessel, the rim of the one below would not have escaped injury. Immediately under this urn-burial was a bunched burial consisting of bones belonging to two adults. Probably the apposition was accidental.

The fourth and southernmost mound was the smallest of all. Eight holes, carried below the base, showed it to be of yellow sand. The only object found was part of a human skull.

Mound near Payne's Woodyard, Clarke County.

This little mound, circular in basal outline, about 200 yards WNW. from the landing, on property of Mr. Jefferson Bush, living nearby, had a height of 4 feet, and a diameter of 40 feet. It was completely dug down by us with the exception of parts around two trees. The composition of this mound was interesting, it being one of the class found in this region and spoken of as "rock-mounds" by the inhabitants. It was composed of sand with a small admixture of clay, and contained a great number of masses of ferruginous sandstone placed together in various parts. These masses were often of irregular shape, but sometimes were triangular, oblong, or roughly circular, some no larger than the head of a child, others possibly seventy-five pounds in weight.

Fig. 3.—Vessel of earthenware. Mound near Payne's Woodyard. (Diameter 3.25 inches.)

Fig. 4.—Vessel of earthenware. Mound near Payne's Woodyard. (Diameter 6.5 inches.)

Apart from human remains, in various parts of the mound, were certain pebbles of a shape well suited for pebble-hammers, but showing no mark of use. As pebbles of similar form lay along the river bank, those in the mound may have been accidentally introduced.

Singly and apart from human remains was an imperforate bowl with rude line and punctate decoration (Fig. 3). Also away from burials was a bowl of perhaps two quarts capacity, of fairly good ware and highly polished (Fig. 4). The rim shows a certain thickening. On it and just below it are encircling lines of a decoration which at first glance one might think were made by a roulette, or notched wheel, of a kind figured and described by Holmes;[1] but on examination it may be seen that these punctate markings are at irregular distances apart. It becomes apparent, then, that as a pointed implement was trailed around the vessel, the impress of the point was made upon the clay. Around the body of the vessel, which has a mortuary perforation of the base, is a single, incised line.

There were also in this mound single fragments of vessels and parts of vessels in fragments, some undecorated, one with the interesting, incised decoration shown in Fig. 5.

FIG. 5.—Fragment of earthenware vessel. Mound near Payne's Woodyard. (Height 4.4 inches.)

One vessel, of which but comparatively small fragments were found, had been decorated in red pigment on the outside, or on part of the outside, and red pigment with incised decoration interiorly. All the earthenware found by us in this mound came from the eastern part —some near the margin, some farther in.

A small, rude cutting implement of chert lay in the sand.

Toward the center of the mound the grouping of masses of rock was more marked. Among these was the first burial found by us, consisting of three fragments of a femur and part of an ulna, 30 inches from the surface.

Almost exactly in a central position in the mound, 3.5 feet down, was the skeleton of an adult, partly flexed on the right side, with the skull badly crushed. It seemed as if a special arrangement had been accorded the masses of rock between which this skeleton lay, as large, flat slabs were above it, as well as below the head and chest.

[1] "Aboriginal Pottery of Eastern United States," 20th An. Rep. Bur. Am. Eth., p. 77.

Mounds near Carney's Bluff, Clarke County.

At the edge of the bluff overlooking the river, about one-half mile north from the landing, in full view from the road, was a symmetrical mound, circular in basal outline, on property belonging to Mr. P. A. Bryant, living nearby. Its height was 5.5 feet; its basal diameter, 46 feet. It had been dug into on the northern side to some extent, previous to our visit.

The mound, which was completely leveled by us, proved to be of sand mingled with masses of rock, similar to the one at Payne's Woodyard.

Fig. 6.—Vessel No. 1. Larger mound near Carney's Bluff. (Diameter 6.75 inches.)

In the sand were a number of pebbles; several arrowheads or knives, of quartzite, broken and whole; several bits of chert; a pebble showing considerable wear; and part of a flat, oval pebble with a central hole of considerable size, which may have been natural, though a roughness of the margin of the hole seemed to indicate that if not artificially made it had at least been enlarged. Several bits of earthenware bearing the small check-stamp lay in the sand.

Eight feet in from the margin of the mound, on the eastern side, 28 inches down, were a number of fragments, presumably of several vessels or of parts of vessels. With these were three vessels and a large fragment, as follows:

Vessel No. 1.—This vessel, of yellow ware, trilateral with circular aperture ornamented with notches, has an incised decoration as shown in Fig. 6. The mortuary base-mutilation is present.

Vessel No. 2.—An undecorated pot of inferior ware, of about three pints

capacity, with slightly flaring rim, parts of which rise above the rest at three irregularly distant points (Fig. 7). There is a basal perforation.

Vessel No. 3.—A curious vessel of coarse, yellow ware, that has had in relief, the head, arms, and hands, of a male figure. The right arm, now missing, with a hand of generous proportions, which still remains, crossed the body, the hand resting upon the left arm (Fig. 8).

The fragment was the lower two-thirds of an undecorated, globular vessel, with a hole knocked through the base.

Certain fragments found nearby belonged to a coarsely-made vessel, partly shown in Fig. 9. The lower part of another effigy-vessel, in many bits, was present in the mound.

Four feet nine inches down was a lone skull, much broken. The frontal part showed no flattening. No other skull present in the mound was in condition to furnish any indication as to cranial compression.

Two feet five inches from the surface were two femurs, one tibia, one humerus,

FIG. 7.—Vessel No. 2. Larger mound near Carney's Bluff. (Diameter 6 inches.)

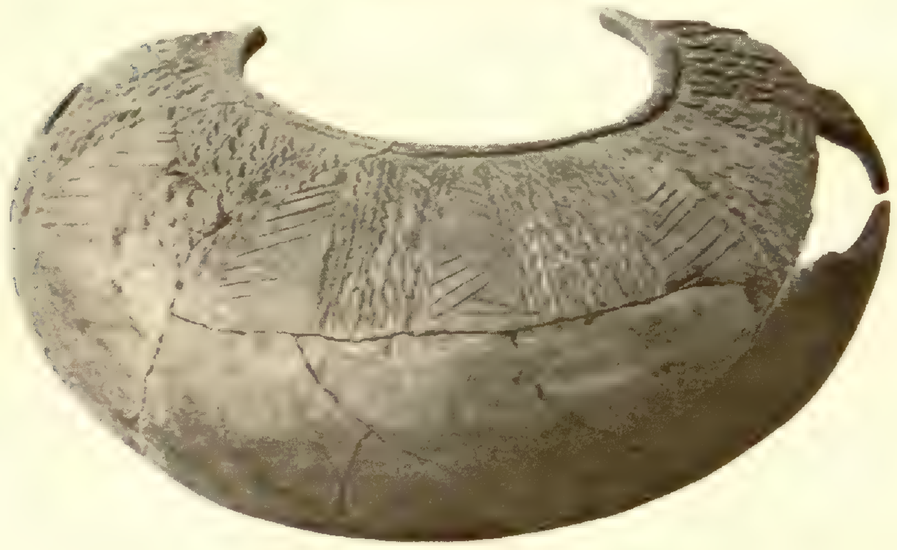


FIG. 9.—Fragment of vessel of earthenware. Larger mound near Carney's Bluff.

FIG. 8.—Vessel No. 3. Larger mound near Carney's Bluff. (Diameter 4.5 inches.)

one radius, one ulna, and certain crushed bones much decayed, also parts of a skull—evidently a bunched burial. Masses of rock lay at each side, and a slab, on its edge, was at one end.

Two feet from the surface were parts of a skull, badly decayed, also one femur, one humerus, one ulna, and one mandible. No rocks lay above this burial, but masses were nearby on the sides and below it.

Below the trench left by the previous diggers were: one lone skull; a skull in fragments, with remains of certain long-bones nearby; fragments of a skull and of a few other bones. These burials were not among masses of rock.

Five feet three inches from the surface was a skull with rocks all around it, having no particular arrangement.

Not far from the base, and almost in the center of the mound, was a skeleton closely flexed on the left side, not immediately associated with masses of rock.

No basal line was visible in this mound, and, therefore, to insure complete investigation, the digging was carried along at a depth considerably greater than the height of the mound, reaching to a depth of 8 feet at times. Almost immediately below the central part of the mound, its base about 9 feet from the surface, was what seemed to be a grave, though its limits on the sides were not distinctly defined. On the base of this grave, with many small fragments of charcoal scattered in the sand, was a skeleton partly flexed on the right side. No masses of rock lay immediately above this skeleton, but 4 feet above it, and continuing to the surface, was a great mass of slabs of ferruginous sandstone, closely piled.

In another part of the mound was a small layer of charcoal which did not seem to be associated with burials.

On the slope of a bluff about one-quarter mile north of the mound just described, also on property of Mr. Bryant, was a mound 5 feet 7 inches high and 30 feet across its circular base. There was no sign of previous disturbance. This mound, which was entirely dug away by us, proved to be of sand with but few masses of rock—practically none being met with in its outer half.

In the sand were three arrowheads or knives, found separately—two rudely made of quartzite, one more carefully fashioned from chert.

In the eastern part of the margin of the mound were fragments of about half of a small undecorated vessel. Several sherds lay here and there in the sand, probably having been introduced into the mound with the material for its building.

Twenty inches down in the outer part of the mound was a small bunched burial, including a much decayed skull, badly crushed.

Farther in, 4 feet from the surface, was a small bunched burial with which no fragments of skull were found.

Near the central part of the mound were two badly decayed skulls in close proximity. Near one of these were two round, flat pebbles of about equal size.

Two or three feet from the center of the mound, 3.5 feet from the surface, was a badly decayed skull.

Although the mound when measured by us showed a height of about 5.5 feet, yet, being on a slope, it is possible that a greater height was accorded by us than it was entitled to. At all events, what seemed to be a base-line ran through the mound, and this base-line was not more than 4 feet from the surface in the higher parts of the mound. A few feet west of the center of the base, beginning at the base and extending downward 3 feet, was a pit of irregular outline, having an average diameter of about 6 feet. At the margin of this pit were two skulls, together. In the upper part of the pit was much clay, and below the clay was black material, probably sand darkened by admixture of organic matter. In this black material were scattered a few small masses of ferruginous sandstone and a part of the base of an earthenware vessel, having one foot and a remnant of another. No human remains were encountered below the margin of this curious pit.

Mound near Gaines' Landing, Washington County.

About one-half mile by water up West Bassett Creek, on the right-hand side going up stream, on property belonging to Mr. Henry L. Gaines, of Mobile, Alabama, is a field lately used for the raising of cotton. In this field, which has been long under cultivation, was a slight rising of the ground, marking where a mound had been almost ploughed away. On the surface were scattered human bones. A circular area 30 feet in diameter was marked out by us and dug away to a depth of about 2.5 feet. The material was clay with a slight admixture of sand.

In several parts of the mound, just below the surface, were scattered human bones where burials had been disturbed during cultivation of the field. Slightly deeper was a large mass of long-bones, parallel with one another. At one end where the mass diminished somewhat in thickness, three skulls, in fragments when found by us, had been placed.

Immediately below the surface were the remains of three urn-burials, consisting of the lower parts of coarse, undecorated, shell-tempered bowls, in fragments but held together by the surrounding clay. Each of these bowls, from which, presumably, the rims had been ploughed away, contained human bones, and one had, in addition, several large fragments of a good-sized vessel of excellent ware, shell-tempered in places and bearing incised decoration, probably belonging to a surmounting vessel.

A stone, pitted on each side, lay alone in the clay.

Mound near Bolan's Woodyard, Washington County.

This mound, about half a mile in a westerly direction from the landing, is about 5 feet in height and 50 feet in diameter, approximately. We were unable to obtain permission to investigate it.

Mounds near Jackson, Clarke County.

About one-quarter mile in a straight line east of the railroad station at Jackson, in pine woods, were two mounds, in sight one from another. The northerly mound,

which had sustained practically no previous investigation, was 43 feet in diameter of base and 2 feet in height. Leaving untouched the outer 3.5 feet on each side of the mound, the remainder, having a diameter of 36 feet, was completely dug through by us, and as no burials were met with until we had gone a number of feet toward the center, it is not likely that anything was missed.

Human remains were found in eleven places, consisting of lone skulls, small bunches, and fragments of bone, all in the last stage of decay.

Found singly, and apart from human remains, in the mound were various imperfect arrowheads; also six entire arrowheads or knives—five of quartzite, one of chert, all rudely wrought.

Presumably having been with a skeleton which had decayed away was an ornament of corrugated sheet-copper (Fig. 10). This type of ornament is more fully described in our account of the shell deposits at Blakeley, Mobile bay.

With a bit of long-bone, having two or three fragments of bone at a certain distance, were, neatly piled together, fourteen arrowheads and knives—twelve of quartzite, two of chert, all unbroken, with one exception. Separated from these by a short distance was a rough arrowhead or knife of quartzite, and an incomplete arrowhead of chert.

With a lone skull were eight arrowheads and knives—seven, entire, of quartzite, one, incomplete, of chert.

At the center of the base of the mound, as nearly as could be determined, was a small bunched burial having two skulls. With this burial was a knife of quartzite; a barrel-shaped bead of earthenware, 1.5 inches long; and a toy-bowl of a soft claystone, about 1.75 inches in diameter. This little toy, interestingly enough, has a mortuary perforation in the base.

FIG. 10.—Ornament of sheet-copper. Mound near Jackson. (Full size.)

The second mound, exceeding twice the height of the other and of about the same diameter, had been badly dug into previous to our visit. Four considerable holes made by us and enlargement of the earlier one yielded nothing.

MOUNDS AT JACKSON LANDING, CLARKE COUNTY.

At Jackson Landing, within the limits of the large saw-mill of the C. W. Zimmerman Manufacturing Company, of which Mr. C. W. Zimmerman, of Jackson, is president, are remains of two mounds which extensive digging by us showed to have been domiciliary, presumably.

Mound in Kimbell's Field, Clarke County.

Kimbell's field, long under cultivation, controlled by Mr. T. I. Kimbell, executor, of Jackson, is about 300 yards northwest of the Zimmerman sawmill at Jackson Landing. The mound, which had been much ploughed over, showed no sign of previous digging. Its height was 5 feet; the diameter of its circular base, 48 feet. It was completely dug away by us, its composition being a mixture of sand, clay, and gravel.

Human remains were met with in forty-five places, the deepest being 3.5 feet from the surface. All bones were in the last stage of decay and crumbling to bits. The burials were as follows:

Isolated skulls—23.

Bunched burials, with a skull but without the full complement of the skeleton—8.

Small bunched burial with two skulls—1.

Small bunched burial without skull—1.

Skull and one long-bone—1.

Skull and two long-bones—1.

A few long-bones together—1.

A single long-bone or a fragment or fragments of one—8.

The remaining burial of the forty-five, 22 inches from the surface, consisted of a skull and certain long-bones. With these were charcoal and less than a handful of bits of calcined bone, the fragments too small to be positively identified as human, though probably they were.

With a fragment of femur was a neat pebble-hammer. With an isolated skull was a mass of mica, roughly elliptical, 6 inches by 7 inches, with a central perforation and a place nearby where another perforation had been unskilfully made or attempted and abandoned.

Unassociated with human remains and found singly were the upper part of a sheet-copper ear-plug of the ordinary type; four arrowheads, three of quartzite, one of chert; a cutting implement wrought from a large quartz pebble; two leaf-shaped implements of quartzite, lying a short distance apart.

A few bits of pottery lay here and there in the mound, some undecorated, some with the small check-stamp, one with lined decoration, another with lined and punctate marking.

In the western margin of the mound was a small, undecorated, imperforate bowl (Vessel No. 1), placed upright in part of another undecorated bowl. Both are of inferior ware.

In the eastern margin, lying mouth down, was a gourd-shaped vessel of excellent ware (Vessel No. 2), with oval aperture, and having a mortuary perforation. There are three annular decorations in relief emphasized by a surrounding depression (Fig. 11).

Much farther toward the center of the mound was Vessel No. 3, in fragments. This vessel, pieced together, is imperforate as to the base, and has a semiglobular body with an octagonal rim bearing punctate decoration, probably made in this instance by a trailing point and not with a roulette, or notched wheel (Fig. 12).

FIG. 11.—Vessel No. 2. Mound in Kimbell's Field. (Diameter 6.75 inches.)

FIG. 12.—Vessel No. 3. Mound in Kimbell's Field. (Diameter 5.4 inches.)

FIG. 13.—Vessel No. 4. Mound in Kimbell's Field. (Diameter 9 inches.)

FIG. 14.—Vessel No. 5. Mound in Kimbell's Field. (Diameter 5.25 inches.)

Toward the center of the mound, together, were five vessels of inferior ware lying above a deposit of human bones, though, as burials were numerous in that part of the mound, the vessels may not have been connected with the remains.

These vessels are as follows:

Vessel No. 4.—This vessel, of yellow ware, and in fragments, since cemented together, has a mortuary perforation of the base. Somewhat below the rim, which has one small projection, is an encircling band made up of a design, four times displayed, consisting of a circle having on each of two opposite sides a pointed oval as shown in Fig. 13. Possibly these emblems in conjunction are a highly conventionalized bird-form. The feather symbol, often found on bird-vessels, upright, forms part of the design at each side.

Vessel No. 5.—This vessel, semiglobular, imperforate, with thickened rim, bears a small check-stamp decoration (Fig. 14).

Vessel No. 6.—A perforate pot with small check-stamp decoration (Fig. 15).

Vessel No. 7.—An undecorated jar having a basal mutilation (Fig. 16).

Vessel No. 8.—A bowl of considerable size, of inferior ware, found in many fragments. The only decoration consists of two encircling, incised lines below the rim.

FIG. 15.—Vessel No. 6. Mound in Kimbell's Field. (Diameter 5 inches.)

FIG. 16.—Vessel No. 7. Mound in Kimbell's Field. (Diameter 4.9 inches.)

Shell-tempered ware was not present in this mound.

At or near what seemed to be the center of the base of the mound, was a pit, roughly circular, apparently beginning at the base, where its diameter was about 5 feet, and converging downward about 20 inches. This pit, which contained no human remains, was filled with the material composing the mound, but colored black with admixture of organic matter. In this material were very many small masses of ferruginous sandstone.

MOUND OPPOSITE PEAVEY'S LANDING, CLARKE COUNTY.

This mound, in sight from the river, is at a nameless landing directly opposite Peavey's Landing, on the other side of the river. The mound, 10 feet in height, formerly oblong in outline, is now irregular from wash of water in flood-time. Its basal diameters are 125 feet NNW. and SSE., and 90 feet ENE. and WSW. The summit plateau is 55 feet by 40 feet in corresponding directions. As the mound evidently was domiciliary, and as its destruction could not be permitted owing to

its advantage as a place of refuge for cattle in high water, investigation was restricted to making a considerable number of holes in the summit plateau to learn whether or not superficial burials had taken place in the mound. Neither human remains nor artifacts were met with. The digging, so far as it went, showed the mound to be of clay.

Mound near Santa Bogue Creek, Washington County.

This mound, in a cultivated field about one-half mile in a southerly direction from the mouth of Santa Bogue creek, was about 1 foot in height and 48 feet in basal diameter. Careful investigation showed the mound to be of sand with a slight admixture of clay. It yielded no material result.

Mound near Malone's Gin, Clarke County.

This mound, on property of Mr. J. M. Deas, of Coffeeville, Alabama, in a cultivated field, about three-quarters of a mile SSE. from the landing, is of irregular outline, its length being 40 feet and its maximum breadth, 28 feet. Its height is 1 foot. A few fragments of charcoal and one or two bits of pottery alone showed the mound, which was of clay, to be of artificial origin.

Near the river bank, below Malone's Gin, are several small shell deposits made up principally of *Quadrula heros*, *Q. pernodosa*, *Q. trapezoides*, *Q. ebena*, *Q. metanevra*, *Lampsilis purpuratus*, *L. claibornensis*, *Obliquaria reflexa*, *Truncilla penita*, *Unio gibbosus*. Scattered over adjacent fields are flakes and small masses of chert; pebble-hammers; bits of quartz; masses of ferruginous sandstone, pitted on each side; arrowheads and knives of quartzite; cutting implements and irregular masses of the same material; fragments of inferior pottery.

Mound near Bass' Landing, Choctaw County.

This mound, in a cornfield, the property of Mr. D. B. Bass, of Bladen Springs, Alabama, is in full view from the river, about one-half mile below Bass' Landing. The mound, which apparently had been subjected to much wash of water, had an irregular outline with basal diameters of 45 feet and 32 feet. Its height was 3 feet 7 inches. Thorough digging showed the mound to have been made of a mixture of sand and clay, with much more sand in some parts than in others. No remains of any kind were discovered.

Mound near Cox's Landing, Clarke County.

This little mound, beautifully situated on the edge of the bluff immediately above the landing, on property of Mr. J. W. Nichols, of Manistee, Alabama, had a basal diameter of 26 feet and an apparent height of but 2 feet. No sign of previous examination was evident. It was entirely dug down by us with the exception of parts around two trees.

Human remains, encountered at the very margin, were found in thirty places, at a depth of from 1 foot to nearly 3 feet. The burials, badly decayed, resembled those found in the mound in Kimbell's Field, lone skulls and mere fragments of long-bones constituting separate interments. In one case decay had gone so far that only a few teeth were present.

With a skull and a bit of long-bone was a mass of galena, about 1.5 inches by 1 inch by .75 inch. Another mass, about double that size, lay with an isolated skull. Galena, lead sulphide, assumes a new importance in the mounds since we know from our investigations at Moundville on the Black Warrior river that the carbonate of lead which forms on the lead sulphide, probably was used as a paint.

A few bits of inferior pottery, a flake or two of chert, several flakes and masses and broken arrowheads, of quartzite lay in the mound apart from human remains.

At some distance from the center, sand slightly darker than that of the mound, and containing scattered fragments of human bone, was noticed. This discolored sand suggested the presence of a pit, but as it seemed to merge more or less with the sand around it, definite limits could not be determined. No base-line was met with in this mound, hence it is impossible to say whether or not a pit found beneath the sand we have described was connected with it or not. Had there been a base-line and that line had been cut through, it would have been evident that the black sand above and the pit below formed parts of the same excavation. In the pit, 5 feet 3 inches from the surface of the mound, was a deposit of sand, 5 feet in length, 3.5 feet in breadth, and 1.5 feet deep, deeply blackened by organic matter. In it were bits of pottery having no relation one to another—not a vessel broken and thrown in. For a certain distance above this dark deposit were scattered, small bits of charcoal.

Dwelling site at Thornton's Upper Landing, Clarke County.

Near this landing, which is 133 miles by water from Mobile, on property of Mr. E. L. Long, of Mobile, and Mr. J. P. Armistead, of Coffeeville, Alabama, are small shell deposits consisting mainly of two vivipara, namely, *Campaloma ponderosum* and *Tulotoma magnifica*, the latter peculiar to the Alabama river system, and several Unionidæ, including *Quadrula cornuta* and *Q. pernodosa*.

The neighboring fields are strewn with the usual debris of dwelling-sites. We gathered a heart-shaped mass of sandstone, pitted on each side, and another, more roughly made, having five pits.

Mound near Powe's Landing, Choctaw County.

This mound, through which a road had been dug, was on property of Mr. H. A. Powe, of Bladen Springs, Alabama, about one-quarter mile below the landing, on the river bank. The mound originally had been about 5 feet high and about 48 feet across the base. The remnants of this mound were dug into to a considerable extent by us without discovery of human bones or artifacts.

Mound near Noble's Gin, Clarke County.

In a cultivated field, the property of the Mobile Lumber Company, of Mobile, was a mound about one-quarter mile above the gin, near the river's bank. This mound, which, evidently, had long been under cultivation, was much spread by the plough and probably reduced in height at the same time. It resembled an irregular ridge 85 feet long. At the narrower end it was 36 feet across. At 55 feet from the latter end it was 49 feet across, its maximum width, and there attained its greatest height, 4 feet 3 inches.

In the surrounding field, the surface of which had been disturbed by the plough and by wash of water in a recent flood, were flakes and small masses, of quartzite, in all directions, but, curiously enough, no fragment of pottery was noticed, although careful search was made.

This mound, which was completely leveled by us, made of clay having a certain admixture of sand, seemingly had not been dug into before our visit, except to place four posts for a small shed for cattle. Near the margin were a few fragments of pottery, bearing a small check-stamp. Farther in were several bits of ordinary ware, undecorated, and one sherd bearing a series of parallel, incised lines. In the marginal parts of the mound, perhaps surface deposits ploughed under, were a number of bits of quartzite and several broken arrowheads; four rough cutting implements; six arrowheads, possibly knives, all quartzite. One arrowhead was rather neatly made, being serrated and having one side flat, the other convex. Under the shed, where probably the material from the post-holes had been thrown, was a small "celt" and a neatly-made gouge of volcanic stone, with a sharp edge concave on one side. With a lone skull was a neatly-made "celt" of volcanic stone, 7 inches long.

No human remains were met with until the outside 10 feet of the mound had been dug away, and burials were infrequent until more central parts of the mound had been reached. There were present, all in the last stage of decay, seventeen burials, from 6 inches to 38 inches below the surface, as follows:

Lone skulls—6.

Small bunches without skulls—5.

Small bunches with skulls—5.

A single femur—1.

With one burial was a quantity of sandy clay colored with red pigment; and in another place, where no burial was found, the clay was reddened where possibly a burial had disappeared through decay.

Mound below Bashi Creek, Clarke County.

About one mile below the mouth of Bashi creek is a cultivated field belonging to the Mobile Lumber Company, of Mobile. About one hundred yards from the river, in this field, is a mound of irregular basal outline, apparently much spread by cultivation and at the same time reduced in height. On the surface of the mound

and in the large surrounding field were many flakes and chippings, mainly of quartzite; and on the mound were small bits of inferior earthenware. The present measurements of the mound are: basal diameters, 220 feet east and west; 180 feet north and south; height, 6.5 feet.

Many excavations yielded two arrowheads or knives, of quartzite, and one of chert. One fragment of bone was met with, too much decayed for identification.

Mound near Bashi Creek, Clarke County.

In a field formerly under cultivation, about one-quarter mile in a southeasterly direction from the mouth of Bashi creek, on property of the Mobile Lumber Company, was a mound that evidently had lost parts of two sides through the agency of the plough. Previous visitors had left a hole in the central part, 3 feet by 4 feet, by 4 feet deep. The mound, which was entirely dug down by us, consisted of a mixture of clay and sand. Its height was a trifle more than 5 feet; its basal measurements, 25 feet by 34 feet.

Human remains were encountered in twelve places, one burial being more than 4 feet deep. The burials, with one exception, resembled in form those in mounds lately described by us, and were fragmentary and badly decayed. Just beneath the surface were a number of bones together, having under them fragments of what had been a vessel or a large part of a vessel of considerable size. The ware, shell-tempered, was inferior and undecorated. Here, doubtless, were the remains of an urn-burial.

With one burial were two flakes of chert.

The bones in this mound were so badly decayed (in one case one fragment only being present with a few teeth), that it is hard to say whether or not objects found alone had been with burials originally. In addition to many flakes, chippings, and small masses of rock, there were in the mound, singly and apparently away from bones, twelve cutting implements, lances, arrowheads, and knives, all of quartzite except one of red chert. There were also in the mound an interesting implement, apparently an arrowhead or knife, utilized as a drill after breakage, an ellipsoidal pebble-hammer, and a ball of granitic rock, about 2.5 inches in diameter.

Lying closely packed together was a deposit of fifty masses of sandstone and of ferruginous sandstone, from the size of a fist downward, together with a slab of the latter stone. A neatly-made smoothing-stone of fine-grained, ferruginous sandstone, apparently shaped to be held in the hand, lay alone.

Fig. 17.—Sherd. Mound near Bashi creek. (About full size.)

While the surface of the surrounding field was strewn with fragments of stone, practically no pottery was in evidence, and in the mound almost an equal scarcity of earthenware was noted. Of several bits met with, one bore the small check-stamp; another, the novel, incised decoration shown in Fig. 17.

About 16 inches from the surface were a number of small fragments of sheet-copper, corroded through and through. On the base of the mound was a copper ear-plug of the usual type or, more correctly speaking, the outer part of the ear-plug was present, that part which was worn behind the lobe of the ear, serving to hold the outer part in place, being missing. Possibly this part had been of some perishable material. Various materials, doubtless, were utilized by the aborigines for the rear portion of the ear-plug. In Florida we found ear-plugs with discs of sheet-copper to be worn in front of the ear, which had been attached to circular bits of earthenware for use behind the lobe.

Just below the surface, together, were two outer halves of ear-plugs of sheet-copper, with beaded margins.

Mound on the Watters' Plantation, Marengo County.

The Watters' plantation, the property of Mr. J. A. Watters, of Mobile, is on the eastern side of the river, opposite Brown's Landing. The mound, 5 feet high and 54 feet across its circular base, is but a few feet from the water's edge, in a cultivated field. There was no sign on the surface of previous digging, the mound presenting a peculiarly uniform and rounded appearance. Later, however, evidence that one or two narrow and superficial holes had been made and refilled, became apparent. As the mound was suitable as a refuge for cattle in flood-time, a marginal part 10 feet in diameter on all sides was left untouched by us, and the part enclosed by this, 34 feet across, was completely dug away at a level somewhat below that of the base of the mound. In this way that part of the mound most exposed to wash of water was left intact, and this was accomplished presumably with no loss to ourselves as nothing material was met with until considerable digging had been done, the first burial found being 5 feet in from where the excavation was commenced. The mound was composed of sand with a small admixture of clay.

At the beginning of our digging, 3.5 feet down, on the base, which was clearly marked in this mound, we came upon a fire-place. We cannot say how far this fire-place extended outward, but when uncovered by us it was present along the circumference of the northern half of the mound and continued in for about 6 feet. It was marked by burnt earth and a layer of charcoal with a maximum thickness of 1.5 inches.

Scattered through the mound were the usual fragments of quartzite; eight arrowheads, knives, scrapers, and drills, of the same material; and one neat little bird-arrowhead of chert, somewhat broken. A few bits of earthenware were scattered through the mound, chiefly undecorated, though two or three bore the small check-stamp.

Human remains were encountered in thirty-two places, mainly in the more

central parts of the mound where were all entire skeletons. The bones, badly decayed, were found from the surface to the base, while one skeleton lay in a pit more than a foot below the base, or more than 6 feet from the surface. The forms of burial were as follows:

Lone skulls—8.

Small bunches with a single skull—2.

Small bunches without skull—6.

Fragments of bone—2.

Skeletons flexed on the right side, including one of an adolescent—4.

Skeletons flexed on the left side, including one of an adolescent and one of a child—6.

Skeleton full length on back—1.

Ten inches below the surface was the lower part of a skeleton, flexed on the left side, extending to the upper part of the thorax. Scattered bones of the upper part lay around. This, probably, was a recent disturbance.

A skull and part of an arm bone lay 29 inches from the surface, in a part of the mound where burials were numerous and where an aboriginal disturbance might have been looked for.

A skull with scattered bones lay 1 foot down.

This completes the list of thirty-two burials.

Behind a flexed skeleton already noted, lay many disarranged bones.

One of the flexed skeletons had resting on the leg bones the skull of a child.

Two of the flexed skeletons in this mound were more closely drawn together than are those we usually call flexed, and verged on the closely flexed.

The lower extremities of a flexed skeleton showed marked pathological changes. A femur, tibia, and fibula belonging to this skeleton have been sent by us to the Army Medical Museum at Washington. The corresponding bones of the other side were badly broken in digging.

In the central part of the mound, separate, were five skeletons associated with charcoal. One of these skeletons had earth colored with red pigment on the trunk, extending to the pelvis, and considerable charcoal near the head. Charcoal was at the head of another skeleton and at the feet of a third. The position of the charcoal in the two other instances is not given in our field-notes.

Near certain scattered bones was a neatly made arrowhead of cehrt.

A flexed skeleton had with it, together, one jasper pebble; two pebbles of the same material, somewhat broken; a drill fashioned from a pebble of jasper; a drill of quartzite; a pointed implement of the same stone, perhaps a drill; a roughly made or unfinished implement; and the end of a rude, pointed tool, the latter two of quartzite.

A flexed skeleton of an adolescent had many shell beads at the neck.

Lying near the pelvis of a skeleton of a child, together, were a piercing implement made from the cannon-bone of a deer; a bone of a raccoon; a quartz pebble; and a pointed fragment of quartzite. With this deposit, curiously enough, con-

sidering that it lay with the bones of a child, where careful search showed no other bones to be near, was a smoking-pipe of earthenware, of the usual type of this region as to form, but of considerably better ware than is looked for in this part of

FIG. 18.—Pipe of earthenware. Mound on Watters' Plantation. (Height 4.12 inches.)

the country when pipes are concerned. The only decoration is an incised, encircling line around the bowl (Fig. 18). Within the pipe was a small, neatly-made fish-hook of bone.

MOUND BELOW HORSE CREEK, CHOCTAW COUNTY.

Another plantation owned by Mr. J. A. Watters is on the west side of the river, about 174 miles by water from Mobile. The plantation, not in the neighborhood of any particular landing, is about one-half mile below the mouth of Horse creek, which enters the river, however, on the opposite, or eastern, side, in Marengo county.

The mound, in a cultivated field, though itself showing no sign of the plough, within 30 yards of the river and parallel with it, is a fine example of a small domiciliary mound, being perfectly square with a flat summit plateau. The diameter of the base is 62 feet; that of the summit plateau, 44 feet. The height is 4 feet 9 inches.

Although it was evident from the shape of the mound that it was constructed for domiciliary purposes, yet to assure ourselves and to detect any surface burials, a considerable part of the mound was dug away. No bone or artifact was encountered.

Mounds below Beaver Creek, Marengo County.

In woods, almost at the water's edge, about one mile below Beaver creek, on property of Mr. Joseph H. Compton, of Nanafalia, Alabama, were four small mounds. These mounds were completely dug down by us with the exception of part around a tree in one mound and of certain marginal portions in all the mounds, which seemed not to have belonged to them originally, but to be due to wash of water. As no bones or artifacts were found until considerable digging had been done by us, it is probable our estimate was a correct one.

The southernmost mound was about 40 yards distant from its nearest neighbor. Its height was 3 feet 3 inches; the diameter of its circular base, 45 feet. Near the eastern side was a deep depression whence material for the mound had come. Previous diggers had left a shallow trench, 5 feet in width, extending inward 19 feet from the eastern margin. Along this trench and in material thrown from it were small fragments of human bones.

The mound, which contained much more sand in the upper than in the lower part, seemingly had been built on a dwelling site which contained the usual debris, including fresh-water mussel-shells (*Lampsilis rectus*, *L. purpuratus*, *L. anodontoides*).

From the mound came pebble-hammers, pebbles, chips of quartzite, small masses of fossil wood, a quantity of limonite with the surface transformed into hematite, and a pebble much worn as a smoothing implement. But few bits of earthenware were met with, and these are of inferior quality. In but two or three cases had there been attempt at decoration, and this, rudely done, is of the kind known as cord-marked, which, as Professor Holmes[1] has shown, is made with the aid of a cord wrapped around a wooden paddle.

Human remains, decayed through and through, were met with in six places, in addition to the fragments of bone referred to as lying near the trench. These burials are as follows:

Burial No. 1.—A fragment of a skull.

Burial No. 2.—A skeleton lying at full length on the back, 2 feet below the surface, with charcoal under it and extending somewhat beyond it.

Burial No. 3.—Four feet from the surface, with charcoal above it, was a full-length skeleton on its back, having near the skull, grouped together, six fragments of quartzite, three of which, fairly sharp at one end, may have seen service as drills. With these were one bit of sandstone, a small jasper, arrowhead, and part of what may have been an implement of bone. On the thorax of this skeleton lay a spearhead or dagger, of quartzite, 7.25 inches long by 2.25 inches wide.

Burial No. 4.—Immediately by the side of Burial No. 3 was an elongated bunch of bones beneath charcoal.

Burial No. 5.—On a layer of charcoal, 3 feet from the surface, lay a skull, with a pair of femurs 2 feet distant.

Burial No. 6.—A skull and certain scattered bones lay 20 inches from the surface, with charcoal beneath them.

[1] "Aboriginal Pottery of Eastern United States." 20th Ann. Rep. Bur. Am. Ethn., p. 73.

The next mound, elliptical in contour, was 36 feet long by 27 feet in maximum width and somewhat less than 2 feet high. It showed no mark of previous digging. This mound was composed of sand mixed with a considerable proportion of clay, and midden refuse lay at the base. One full-length skeleton, lying on the back, was the only occurrence of human remains. An implement of chert, about 5 inches long, probably a knife, showing a flat cleavage on one side and considerable work on the other, lay alone in the earth, as did a pointed implement of quartzite.

The next mound was practically in contact with the one to the south of it. Its height was 4.5 feet; the diameter of its circular base, 40 feet. It was almost of pure sand, no midden refuse lying on the base.

Human remains, all badly decayed, were three times encountered.

Eighteen inches down were the remains of a skull and fragments of a long-bone.

All that was left of what had been a burial flexed on the left side, lay 15 inches from the surface.

At a depth of 18 inches were fragments of what had been a skeleton at full length on the back.

This mound, which was symmetrical and practically untouched previously, surprised us by the paucity of its yield.

The fourth mound was about 60 yards farther north. Its base, roughly circular, had a diameter of 30 feet; its height was 3 feet. This mound, almost of pure clay, was completely dug away with the exception of the part around a large tree to which reference has been made, without discovery of artifact or bone.

Mounds near Mouth of Beaver Creek, Marengo County.

In thick swamp, which is under water in high stages of the river, about one-half mile in an ENE. direction from the south side of the mouth of Beaver creek, on property of the Misses Luther, of Luther's Store, Alabama, is a group of fourteen mounds, according to our count, though possibly some escaped us. These mounds, of sand, in close proximity one to another, have circular bases as a rule, though some are slightly elliptical. Among the mounds are many steep depressions whence sand for the building of the mounds was taken, and, in obtaining measurements of height, it is wise to be on level ground and not in one of these depressions, lest undue altitude be accorded the mounds. In size these mounds vary considerably. The largest has basal diameters of 38 feet by 33 feet, and a height of 4 feet 8 inches. The smallest mound, excluding certain insignificant elevations as to the nature of which we are not sure, has a basal diameter of 23 feet and a height of about 2 feet.

As all these mounds serve as a refuge for cattle when the swamp is under water, it was not our wish to destroy them; therefore, the four southernmost mounds, three of the largest and one of the smallest, were dug out centrally to

their bases, the excavations having, respectively, diameters of 16 feet, 17 feet, 12 feet, and 11 feet. These excavations afterward were carefully refilled.

Not a single fragment of earthenware was met with in the mounds, nor were the usual bits of stone present. One rough piercing implement of quartzite lay alone, as did a flat pendant of slaty stone, about 3.75 inches in length, with an elongated, pear-shaped outline.

Human remains were hopelessly decayed. In one mound were: what was left of a skeleton lying at full length on the back; a skull and two small fragments of long-bone; and a skull, two scapulæ and, perhaps, parts of two humeri with another skull 5 inches lower. On the base of this mound was a skeleton lying at full length on the back. Near the skull were seven ordinary river pebbles, eighteen fragments of pebbles, one small arrowhead of jasper, one rude, pointed implement of quartzite, and one fragment of shell. With these were two fragments of a jaw of a wildcat, kindly identified for us by Prof. F. A. Lucas.

In another mound was a lone skull 18 inches down, and, lying on what we judged to be the center of the base of the mound, traces of a full-length burial.

A third mound had a lone skull 16 inches from the surface and, centrally on the base, a skeleton flexed on the right side with a bunch of bones beside it, including three skulls.

The only human remains met with in one of the three largest mounds were parts of a skull.

This grouping together of a considerable number of small mounds, which is first met with at this place, going north on the Tombigbee, is noted here and there, following the river for a distance of seventeen miles until Bickley's Landing is reached, where, in 1901, we found forty small mounds together. Above this point such groups of small mounds are not encountered on the Tombigbee.

Mounds near Breckenridge Landing, Marengo County.

In high swamp, about one-half mile NNE. from the landing, at and near a settlement of colored persons, is a group of small mounds on property belonging to Messrs. J. D. Carter and Brother, of Myrtlewood, Alabama Certain of these mounds are in thick brush, some in open woods, a few in a cultivated field; others are immediately in the settlement. It is our belief that we failed to make an entirely accurate count of these mounds. Presumably some escaped our enumeration and others were twice included. At all events, the mounds number between forty and fifty—certainly more than forty. In height they range between 1 foot and slightly less than 6 feet, though the latter height is exceptional. In basal diameter the mounds are between 15 feet and 45 feet. We did not note at this place the presence of shallow pits or of deep depressions whence material had been taken, which were so numerous in the group of mounds near Beaver creek.

As these mounds are resorted to by cattle when the river overflows its banks, we felt constrained to limit our investigation of them to the method we had adopted with the mounds near the mouth of Beaver creek—by excavating the central por-

tion of certain of the mounds down to the base, and afterward returning the material.

Eight mounds, all of sand with a slight admixture of clay, were treated by us in this way. The few scattering sherds met with are of inferior ware, are not shell-tempered, and, where decorated at all, bear a cord-marked impression, with one exception, which has the small check-stamp.

All bones in these mounds were badly decayed. There was one noticeable feature as to burials; skulls had been placed to the east of the bones they accompanied, whether the burial was what was left of a skeleton or was of the bunched variety.

Mound Number 1.—This mound, measuring 4 feet 6 inches high, and 29 feet across its base, had a core 10 feet in diameter dug from its center by us. An arrowhead of quartzite lay apart from bones. Nine inches from the surface, centrally in the mound, were a skull, two femurs, and a fragment of a small bone.

Mound Number 2.—Height, 2 feet 8 inches; diameter, 24 feet across its circular base. The diameter of the portion excavated was 10 feet. A skull lay 28 inches from the surface. At the same depth, but some distance away, were fragments of bone, probably human. Near the skull was a nest of pebbles evidently carefully selected, as each was nearly round and about the size of a small pea. Presumably they formed part of a rattle, the turtle-shell belonging to which had decayed away. With the pebbles were six small arrowheads of jasper, rather roughly made; a neat drill wrought from a jasper pebble, still showing the rough surface of the stone on its base; also eight pebbles and bits of pebbles.

Mound Number 3.—Height, 5 feet 6 inches; diameter, 33 feet; diameter of portion excavated, 16 feet. Centrally in the mound, 2 feet down, was a skull with two phalanges nearby. Next came a space devoid of bones or artifacts, and then a pelvis and two femurs in line as if they belonged to a skeleton from which the ribs and vertebræ had been taken or had disappeared through decay. Beside the skull was a considerable deposit, as follows: three "celts," 10 inches, 7 inches, 3.75 inches, in length, respectively, one of volcanic rock, two presented to the owner of the mound without identification; three cannon-bones of deer; four pebbles, each about the size of a child's fist, three apparently used as smoothing-stones, one probably as a hammer; a mass of what chemical analysis has shown to be glauconite, or green earth, which takes its color from iron in the ferrous state, presumably used as a paint; fragments of fresh-water shells; six small, barbless fish-hooks of bone, all more or less broken; five small arrowpoints, four of jasper, one of quartzite; one bit of pottery; 37 pebbles, bits of pebbles and small masses of stone, all jasper or quartzite; an unidentified object, perhaps a fossil; a foot-bone of a deer; a piercing implement of bone; four masses of red, or brick, clay; a claw not affording features for positive identification; part of a jaw of a wildcat; an incisor of a beaver; a tooth of a woodchuck; a penis-bone of an otter; the foot-bones of a large

panther (*Felis concolor*). The last five identifications kindly were made for us by Prof. F. A. Lucas.

Centrally, on the base of the mound, was a bunched burial, including certain bones of a child. At the eastern end of the deposit were two adult skulls and one belonging to a child. With these were a few cylindrical, shell beads, each about an inch in length.

Mound Number 4.—This was situated in a cleared field, and had been ploughed over to some extent. Its height was 4.5 feet; its major and minor diameters 46 feet and 36 feet, respectively. This mound, which was almost surrounded by a shallow trench, was completely leveled by us. About 3 feet down, considerably to one side of the center, was a burial similar to one we have described before as found at this place, where a space without bones lay between the skull and the pelvis. From the pelvis two femurs and two tibiæ extended in proper order. Probably the foot-bones were dug away by our men. On or near the center of the base, 43 inches down, was a skeleton flexed on the right side. Back of the skeleton was a bunched burial having one skull. Over this burial, but not over the skeleton, was charcoal.

Mound Number 5.—Height, 1 foot 10 inches; basal diameter, 19 feet; portion centrally dug out, 12 feet. Twenty-two inches down were a skull, then a space without bones, and then, on the same level, a pelvis with two femurs in place extending from it. Near the skull, the earth was colored red. In a deposit along side were: one pebble; one arrowhead of quartzite; five small arrowpoints of jasper; part of an undecorated smoking-pipe of an ordinary type, and a mass of clay material. On top of the skull lay a badly-decayed bone of a lower animal, and a lancehead of quartzite, 4.5 inches in length.

Mound Number 6.—Height, 1 foot; diameter, 16 feet; portion excavated, 11 feet across. Ten inches down were a skull, a fragment of scapula, two humeri, part of an ulna, and a bit of bone on the other side of the skeleton where the forearm would have been. Next came a pelvis in position and at a proper distance from the skull. Extending from the pelvis were two femurs. Near the skull were a small, unbarbed fish-hook of bone, grooved for a line at one end; several small bits of pottery and a few chippings from pebbles. With this material were two human phalanges.

Mound Number 7.—Height, 1 foot 6 inches; diameter, 19 feet; a core 12 feet across was dug out by us. In it were a lone skull and several fragments of pebbles.

Mound Number 8.—Height, 1 foot 8 inches; diameter, 21 feet; 11 feet of the inside dug out by us. Just under the surface was a deposit consisting of a good-sized arrowhead of quartzite; one bit of pottery; 29 fragments of pebbles; two

bits of animal bone, badly decayed; a diminutive arrowhead of jasper; a neat drill made from a jasper pebble; a piercing implement of bone. At a depth of 1 foot, and 1 foot distant from the deposit just described, was a skull, followed by a space occupied only by a fragment resembling part of an arm-bone. Next came a decaying bit of pelvis and two femurs rightly placed, having two tibiæ flexed back.

About one mile from Breckenridge Landing, in a SE. direction, is a group of about twenty small mounds which the owner is unwilling to have investigated.

Mound near Steiner's Landing, Choctaw County.

About one-half mile in a southerly direction from Steiner's Landing, on property of the Allison Lumber Company, of Bellamy, Alabama, about 50 yards from the water, was a mound of elongated oval outline, that had long been under cultivation. Fragments of bone lay here and there on the surface. Its length was 54 feet; its maximum width, which was at 39 feet from the narrower end, was 34 feet; here also the mound attained its maximum height, 2.5 feet. The mound, which showed no sign of former digging, but was completely leveled by us, was composed of sand with an admixture of clay. In it, apart from human remains, were several jasper pebbles; one arrowhead or knife, of quartzite; and a small arrowhead of jasper. On the surface lay an arrowhead of quartz. A few bits of inferior ware, without shell-tempering, were scattered throughout the mound. Decoration, when present, was of the cord-marked kind previously referred to. An undecorated smoking-pipe of earthenware, of the type common to this region, which unfortunately was shattered by a blow from a spade, lay apart from burials.

In the higher part of the mound, 2 feet from the surface, lay what was left of a skeleton which had been at full length on the back. Over the trunk was charcoal. Near the head were two broken pebbles of jasper and fragments of fresh-water mussel-shells. At the shoulder was a handsomely polished "celt" of volcanic stone, about 6 inches in length.

In the same part of the mound, near the surface, was a lone skull.

It is probable that this mound had been much higher at one time and that certain burials have been ploughed away during its cultivation.

One-half mile north of Steiner's Landing are two small mounds in which we were not permitted to dig on account of a recent change in ownership.

Mounds near Rembert's Landing, Marengo County.

In woods, the property of Mr. D. J. Meador, of Myrtlewood, Alabama, about one mile in a westerly direction from the landing, is a group of symmetrical little mounds, all near to one another, some actually in contact. These mounds, 31 in number, according to our count, which perhaps omitted some, were smaller than certain ones in the group near Breckenridge Landing, none exceeding 4 feet in height, though some seemed to do so, owing to depressions near them whence material for their construction had been taken.

Seven of these mounds were dug by us in the same way that those near Breckenridge Landing were treated, and proved to be of sand with an admixture of clay, some having considerably more clay than others.

Human remains in these mounds were so hopelessly decayed that presumably some burials had totally disappeared.

Mound Number 1.—Height, 3 feet 4 inches; basal diameter, 26 feet, the central 12 feet of which were dug out by us. At seven inches below the surface of this circular mound was what was left of a skull. Twenty inches down was a bunched burial made up of a skull and a number of long-bones, and a mass of material too much decayed to identify. The skull in this case was to the west of the bunch. Near it were several pebbles and small masses of rock, also a flat, roughly circular mass of hematite, 6.5 inches by 7.5 inches, pitted on each side, the depressions being highly polished. On the base of this mound were marks of where a large fire had been.

Mound Number 2.—A trifle over 2 feet in height, and 20 feet across the base. The central 9 feet were dug from it by us. East of the center, 16 inches down, were the remains of a skull, some distance to the west from which, at the same level, were fragments of two long-bones.

Mound Number 3.—Height, 2 feet 3 inches; diameter, 19 feet; a core 9 feet in diameter dug from its center by us. Somewhat east of the central part of the mound, 6 inches down, were fragments of a skull. At a depth of 2 feet, west of the center, was a skull, then a space without bones, then a femur, and a fragment of bone, perhaps representing another femur, both at right angles to an imaginary line drawn through the skull. Two sherds of inferior, cord-marked ware and an arrowhead of quartzite came from this mound.

Mound Number 4.—This mound was 2 feet 8 inches high, 23 feet in diameter, the central 10 feet of which were dug out by us. Neither bone nor artifact was encountered.

Mound Number 5.—Height, 2 feet; diameter, 17 feet. On the base of the mound which was entirely dug away by us, was a fireplace on which was a small fragment of skull, black, but whether through the agency of fire or stained by charcoal was not apparent.

Mound Number 6.—This mound was 1 foot 3 inches high, and 17 feet in diameter. A central portion 12 feet across was investigated. Somewhat to the east of the center were remains of a skull; some distance to the west were fragments of bone. A few pebbles and small masses of rock, somewhat chipped, came from this mound.

MAP OF TOMBIGBEE RIVER FROM COLUMBUS
SHOWING DISTINCTIVE AREAS

Mound Number 7.—Height, 15 inches; diameter, 20 feet. The central part of this mound, 12 feet in diameter, was excavated. Fourteen inches down were fragments of long-bones, parallel. At the same level, somewhat to the west, were parts of a skull.

The next landing above Rembert's is Bickley's, where our former work on the Tombigbee ended. The river, therefore, has been covered by us from Columbus, Miss., to its junction with the Alabama river.

The Tombigbee river[1] from its junction with the Alabama to Columbus, Mississippi, practically the head of navigation, 334 miles above, by water, while it yielded to our search but few artifacts and but little new in the way of data, is of interest on account of the comparatively sharp limits confining the practice of certain aboriginal customs along its course. Realizing that later investigation by others may modify conclusions based on our work, we shall, with the help of the accompanying map, outline these areas as noted by us.

At Hooks' Plantation, 17 miles above the junction of the Tombigbee and Alabama rivers, and at Three Rivers Landing, 20 miles above the junction, the character of some artifacts found shows European influence.

At Hooks' Plantation, at Three Rivers Landing, and at Gaines' Landing, 27 miles above Three Rivers Landing, urn-burials were present in the mounds. In the mound near Bashi creek, 66 miles farther up the river, however, were the remains of a single urn-burial.

At Payne's Woodyard, 35 miles above the junction, at Carney's Bluff, 10 miles farther up, were the "rock mounds."

At Payne's Woodyard, at Carney's Bluff, in the mound in Kimbell's Field, 10 miles above Carney's Bluff, entire vessels of earthenware had been placed in the mounds as offerings to the dead. If we exclude urn-burials, a different custom entirely, no other votive offerings of vessels of earthenware were met with by us on the whole river, with the exception of one small vessel of inferior ware found just below Columbus, Miss.

At Beaver creek, 139 miles above the junction, and again north of Beaver creek; at Breckenridge Landing, 5 miles above Beaver creek; at Rembert's Landing, 11 miles farther up the river; and at Bickley's Landing, one mile above Rembert's, were found numerous small mounds grouped together. These localities are all on the eastern side of the river and are within an area having a diameter of six miles.

At Bryan's Burn, 159 miles above the junction, the region of the great domiciliary mounds begins and continues northward as far as our investigations went. Opposite Peavey's Landing, however, 88 miles below Bryan's Burn, is a domiciliary mound of a size entitling it to rank among the great ones of the upper river.

[1] In summing up we shall include, also, that part of the river investigated by us in 1901. All distances given are measured miles, following the course of the river.

CERTAIN ABORIGINAL REMAINS ON MOBILE BAY AND ON MISSISSIPPI SOUND.

By Clarence B. Moore.

Mobile bay, about forty miles in length and twenty-three miles across at its broadest part, is almost surrounded by Baldwin and Mobile counties, in the State of Alabama. An opening at the south connects the bay with the Gulf of Mexico.

As shown on the accompanying map, Mississippi sound extends to the westward of Mobile bay, bordering part of Alabama and Mississippi. Its length is about eighty miles; its width, from five to twelve miles.

Mr. J. S. Raybon, captain of our steamer, who is very familiar with mounds and persistent in locating them, with a companion searched the shores of Mobile bay, with the exception of the western side, and carefully traversed the territory bordering Mississippi sound, in advance of our visit. After our arrival, the western coast of Mobile bay was examined by us in the endeavor to locate mounds.

In this report is given the result of our work in 1905 on Mobile bay, which is meager, and the outcome of our search along Mississippi sound as far as Biloxi, Miss. which is purely negative. At Biloxi, somewhat more than half the length of the sound having been covered, our work was abandoned, as our agent reported no mounds of importance beyond, and because our work on the sound had been so discouraging.

The warm thanks of the Academy are tendered to owners of mounds and of sites around Mobile bay and along Mississippi sound for courteous permission to conduct investigations on their properties.

Mounds and Sites Investigated on Mobile Bay.

Mounds on Simpson Island, Baldwin county, Alabama (3).
Shell deposit at Blakeley, Baldwin County.
Mound near Starke's wharf, Baldwin County.
Shell mound near Fish river, Baldwin County.
Shell ridge near Bon Secours river, Baldwin County.
Mounds on Seymour's bluff, Baldwin County (7).
Shell bank, Strong's bayou, Baldwin County.

Mound on Bottle creek, Baldwin County.

Mounds and Sites Investigated on Mississippi Sound.

Shell deposit on Dauphin island, Mobile county, Alabama.
Mounds near Coden bayou, Mobile County (4).
Mounds near Bayou Batre, Mobile County (2).
Mound near Mary Walker bayou, Jackson county, Mississippi.
Mounds near Graveline bayou, Jackson County (7).
Mounds near Belle Fontaine point, Jackson County (2).
Mound on Tchu la Cabawfa river, Harrison County, Mississippi.

MOUNDS AND SITES INVESTIGATED ON MOBILE BAY.

Mounds on Simpson Island, Baldwin County, Alabama.

Simpson island, the southern extremity of which is about three miles in a northeasterly direction from Mobile, is about 18 miles in length. It is one of a number of islands to the north of Mobile bay. Its western boundaries are the Mobile and Spanish rivers; its eastern, Lizard creek and Tensas river; the junction of Mobile river and Lizard creek forms its northern boundary; Raft river bounds it on the south. The northern portion of the island is the property of Mr. Thomas M. McMillan, of Mobile, Alabama.

About two miles from the northern end of the island, on the western side, about 75 yards from the river's bank, in dense cane-brake in the swamp, is a symmetrical mound a trifle more than 7 feet in height. Its circular base is about 56 feet across.

A number of excavations indicated the mound to be composed of a mixture of swamp-mud and small clam-shells (*Rangia cuneata*). No indication of its use for burial purposes was met with, and presumably its character was domiciliary.

About one mile below the mound just described, on the same side of the island, is a clearing with frame houses upon it. About 250 yards in a southerly direction from the houses, on the cultivated ground, not far from the water on the west and contiguous to the swamp on the east, was a mound, circular in outline, 3 feet in height and 87 feet in basal diameter.

As this mound, composed of a large percentage of shell (*Rangia cuneata*) mixed with tenacious muck, is regarded as a stable refuge in high stages of the river, its demolition was considered inadvisable. Permission, however, was granted to dig most of the mound, leaving the margin undisturbed and solid against wash of water. Therefore, a central portion 50 feet in diameter was dug out by us and subsequently refilled.

In two places, at least, masses of lime reduced from the shell by fire, were encountered. Throughout the mound, very sparingly, were bones of lower animals, including teeth of alligators. The usual dwelling-site material was present, including hones of ferruginous sandstone, pebbles, pebble-hammers, smoothing-stones, a pebble roughly chipped to a cutting edge at each end, and a tine of stag-horn sharpened at the end, like a narrow chisel.

Fragments of earthenware were not markedly numerous. The ware graded from inferior to excellent, some shell-tempered, some not. Decoration, when present, was incised, or the small check-stamp, or showed curved imprints as if made by a finger-nail or a section of a reed. The head of a frog and the head of a duck, ornaments from earthenware vessels, were met with, as were several loop-shaped handles.

Human remains, all badly decayed, were abundant. No cranium was recovered in condition to preserve, though in several instances frontal parts showed no mark of compression. No burial lay deeper than 18 inches, while many were nearer the surface. In many cases were found bones thrown carelessly together as if from recent disturbance; but owing to the dark material from which the mound was made, being the same as that on the surface, it was impossible to say if recent digging had been done or not, the usual evidence, *i. e.*, material of a different color let into the mound, being absent in this case.

Many fragments of human remains, having the appearance of aboriginal disturbances, lay scattered through the mound, and, in addition, near a number of skeletons, were disconnected bones having no relation to them.

Excluding these disturbances of bones, aboriginal or otherwise, there were present, in the portion of the mound dug by us, twenty-nine burials, as follows:

Bunched burials—15.

Skeletons at full length on the back—4.

Skeletons at full length, face down—3.

Burials to be described particularly—7.

One skeleton lay face downward as far as the knees, the legs being drawn back against the thighs.

In a little pile were most, if not all, of the bones of a child, including the skull.

Two burials were lone skulls in fragments.

One skeleton lay partly flexed on the back, the knees upturned and directed toward the left.

The skeleton of an infant lay alone.

Near the northeastern margin of the mound lay the skeleton of an adult, on its back, with head to the east, the skull turned slightly to one side. Completely covering the skull, the rim resting on some of the cervical vertebræ, was an inverted, imperforate bowl, the base but 8 inches from the surface. This bowl (Fig. 1), of solid ware, having a maximum diameter of 11.75 and a height of 3.75 inches, bears an interesting, incised decoration consisting of a variety of symbols, a portion of which, representative of all, is shown diagrammatically in Fig. 2.

FIG. 1.—Bowl found turned over skull. Mound on Simpson Island. (Diameter 11.75 inches.)

This burial, which may be called a kind of urn-burial, occurring in Alabama, is of considerable interest inasmuch as this form of urn-burial, namely an entire skeleton, the skull belonging to which is covered by an inverted bowl, has not been described, to our knowledge, as met with farther eastward than Arizona and New Mexico.[1] Along the northwestern Florida coast we found urn-burials where isolated skulls or skulls with a few scattered bones, were covered by large bowls inverted over them, but this form of urn-burial is different from that found on Simpson island. The burial here detailed is the only one of the kind we have met with, with the exception of one, somewhat resembling it, found by us in a mound near Three Rivers Landing, Tombigbee river, Alabama.[2]

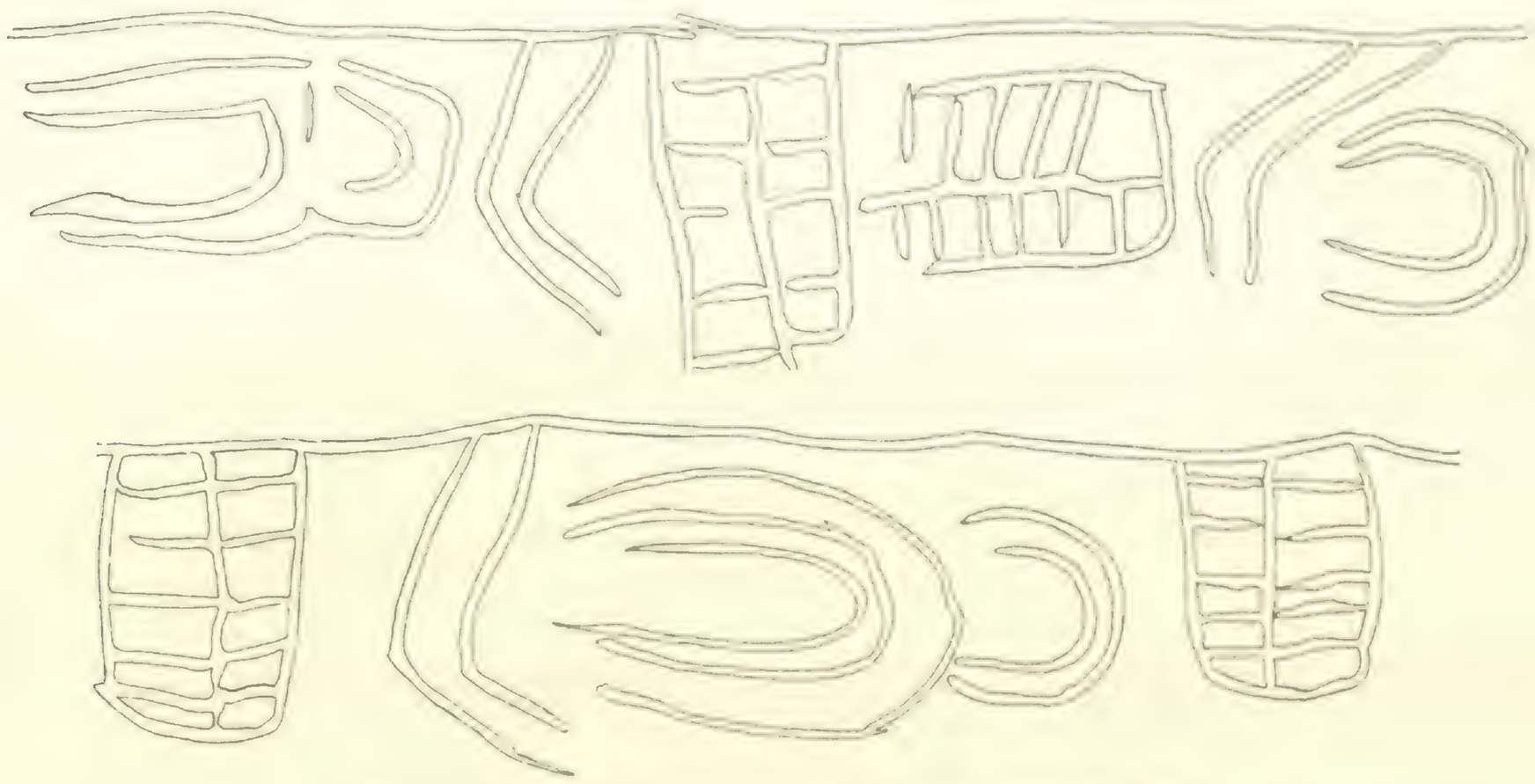


FIG. 2.—Decoration on vessel from Simpson Island. (About half size.)

Certain bunched burials in this mound were noteworthy as showing careful arrangement. One was made up of the bones of an adult and those of a child, including the skulls. One consisted of a considerable bunch of long-bones, all parallel, but without skulls. Another was composed of two series of long-bones carefully arranged, the upper at right angles to the lower. On the bunch last mentioned were two skulls.

No bunched burial had more than two skulls, with one exception. A central bunch or layer, 8 feet long, 14 to 22 inches in breadth, was made up mostly of long-bones, not thrown in promiscuously but carefully piled, among which were femurs representing ten individuals. With this bunch were five crania.

Below the knee of the skeleton of an adult was a discoidal stone, 3.25 inches

[1] Clarence B. Moore, "Aboriginal Urn-burial in the United States," American Anthropologist, Oct.–Dec., 1904.

[2] "Certain Aboriginal Remains of the Lower Tombigbee River," Journ. Acad. Nat. Sci. of Phila., Vol. XIII, p. 251.

in diameter, rather roughly made, the only artifact, with the exception of the bowl, that was found with human remains in this mound.

About one hundred paces through the swamp in a SSE. direction from the mound just described, is a mound of irregular outline, with basal diameters of 121 feet and 150 feet. Its height is 3.5 feet. Eighteen excavations made by us, each 3 feet square at the opening, showed the mound to be mainly of the same material as its neighbor, though one excavation yielded shell alone. At one point a skeleton, lying at full length on its back, was found.

In the Smithsonian Report for 1878[1] an account is given of the finding of an urn-burial in a shell deposit on Simpson island, but the exact location of the deposit is not specified. Two shell deposits on the southern part of this island were visited by us, one on Raft river, the other on Grand bay. These deposits seemed general over the surface, no defined heaps being noted. The discovery of burials in such localities, where the area is too great for systematic investigation, must depend on chance alone.

Shell Deposit at Blakeley, Baldwin County.

Blakeley, a small settlement, is on the mainland opposite the junction of the Tensas and Apalachee rivers.

About one-quarter mile in a southerly direction from Blakeley, bordering the water and extending back, is a shell deposit a number of acres in extent. The exact area of this deposit would be impossible to determine, much being covered by swamp-mud, fallen trees in the swamp holding quantities of shell among their upturned roots. The deposit, made up of small clam-shells (*Rangia cuneata*) with considerable admixture of loam, varies much in height, 6 to 7 feet probably being the maximum; but this is quite exceptional and is confined to several small areas. Considerable shell material has been hauled away, leaving human bones, here and there, upon the surface.

Eleven excavations, each 3 feet square, and from 2 to 3 feet deep (which was about the height of that part of the deposit), were made by us by way of trial. In some, human bones were encountered; in others, not.

In one hole, not far from the surface, were parts of four skulls, and other scattered bones. At a depth of 16 inches was a circular deposit of fragments of cremated, human bones, 10 inches in diameter, 4 inches deep. No sign of fire marked the immediate vicinity of this deposit. Just above the bones lay a tool with a blunt point, made from an antler of a deer, showing no mark of fire. Thirty-two inches from the cremated remains, in the same hole, at about the same level, was a mass of fragments of calcined shell, including, however, a number of shells showing no trace of fire. No charcoal was present with this deposit. About 1 foot below a skeleton which lay near the cremated remains, was another skeleton, flexed on the left side. One hand resting on the neck was in contact with an ornament of

[1] Page 290.

sheet-copper that had imparted a green color to some of the bones of the hand and to at least one of the cervical vertebræ. This ornament, 3 inches long by 1.5 inches wide, is corrugated on one side and belongs to a type common to the mound at Crystal river, northwest Florida; the larger mound at Murphy island, St. Johns river, Florida, and other localities. With the copper lay two mussel-shells. One (*Lampsilis anodontoides*) shows a perforation at one end; the other was broken to fragments in digging. Near the skull of the skeleton on which was the copper ornament lay an isolated calvarium.

In another excavation were a few scattered human bones.

In a third hole was a considerable deposit of fragments of calcined shell, without charcoal but containing also unburnt shells, similar to the deposit described before. On this material, 32 inches from the surface, lay a skeleton flexed to the left. Near this skeleton, but about 8 inches higher, lay another skeleton, flexed on the right side. In another part of the same hole were a few scattered bones.

These were the only trial-holes that yielded human remains.

Comparatively few sherds were met with during the digging. One fragment, the base of a pot, has three feet.

It was determined by us to make additional excavations near that part of the shell deposit where the three trial-holes, which were all near to each other, had been productive. Seven additional holes, therefore, were sunk, five being 6 feet square each, one 5 feet square, and another 5 feet by 10 feet. Subsequently, these excavations were greatly enlarged until some of them joined. All were carried to a depth of more than 4 feet, seemingly the height of the deposit at that place, where their abandonment was necessary as water-level had been reached. Shell, however, continued down an undetermined distance.

Burials were found almost exclusively in two adjacent excavations which, subsequently, were merged. The bones, unusually soft for those that have been reinforced with lime-salts coming from shell, were in no case, but one, more than 2 feet 8 inches from the surface. The exception, scattered bones, lay at a depth of 3 feet 8 inches.

Disconnected bones, and aboriginal disturbances where, apparently, burials had been cut through in making other graves, were met with in a number of instances. In addition, burials were encountered as follows:

Skeletons closely flexed on the right side—2.
Skeletons flexed on the right side—4.
Skeletons closely flexed on the left side—2.
Skeleton flexed on the left side (a child)—1.
Skeletons at full length on the back, including two infants side by side—4.
Skeleton at full length, face down—1.
Skeleton at full length on back, to knees which were bent at right angles (child)—1.
Skeleton closely flexed, the trunk chest downward, the legs to the left—1.
Young infant, at full length, exact position not determinable—1.

Certain skeletons given above deserve particular notice:

The skeleton of an adult, at full length on the back, had three slabs of ferruginous sandstone around the skull. Back of the head, on edge, was a slab 7 inches by 4 inches, approximately, and 1 inch thick. In front of the face and a little under it was a slab about 6 inches square. Another, about half the size of the foregoing, lay on its side in front of the mouth. Two additional slabs lay on the thorax, one below the other, and another lay at the left side of the skeleton.

A skeleton at full length, face down, had below the skull a small, undecorated pot of inferior ware, with a basal perforation, and around the cranium three slabs of ferruginous sandstone. On the thorax lay an additional slab, and another lay on the pelvis. On the thighs were two fragments of a decorated vessel of earthenware, shown in Fig. 3.

FIG. 3.—Fragments of earthenware. Shell deposit at Blakeley. (About full size.)

In two or three other instances, burials with slabs, similar to those we have described, were met with. In one case a stone lay over a skull; in another burial single slabs lay under the skull, on the thorax, and somewhat under the left side of the pelvis.

An arrowhead or knife, of chert lay on the chest of the skeleton of an infant.

Apart from human remains were a rough cutting implement of quartzite; an arrowhead or knife and a fragment of an arrowhead, of the same material.

But few bits of earthenware were encountered during these excavations. One, of excellent ware, shows ornamentation with red paint. One base of a vessel has three feet; two have four feet each. So far as noted by us, no ware in this deposit was shell-tempered.

Though care was taken to observe, it was impossible, so far as our experience went, to say whether the burials in this shell deposit were made from the present surface or during the growth of the deposit. The uniformity in color of the entire deposit made the detection of intrusive burials impossible.

Mound near Starke's Wharf, Baldwin County.

Starke's wharf is on the northeastern part of Mobile bay.

About one-half mile in a N. by W. direction, a little back from the bay, is an abandoned settlement. Within the limits of this settlement was a mound of sand, 5 feet 6 inches in height and about 64 feet across its circular base, on property belonging to Mr. George H. Hoyle, of Battle's, Alabama.

The mound, which was somewhat spread, had undergone previous digging to the extent of a narrow but deep hole in the center, part of which had been filled again. The mound was entirely leveled by us.

In surface-material were two glass beads and a bit of sheet-lead, found separately. At the bottom of the previous excavation, beneath several feet of sand, was the iron blade of a spade. A beginner, misled by this discovery, might readily assign an unduly late origin to the mound.

In the outer part of the mound no burials were met with. At some distance from the margin lay the decaying remnants of a skull with a hone of ferruginous sandstone. There is an outcropping of this rock on the shore of the bay, not far from the mound.

When the mound, which was surrounded by diggers, had been reduced to diameters of 28 and 37 feet, various burials were met with and continued to be found until the center of the mound was reached,—one at 18 inches, some at 2.5 feet, but usually from 3.5 to 5 feet, from the surface. Two burials lay 6 feet down. All bones were in the last stage of decay, being mere fragments which crumbled under pressure. Burials were as follows:

Lone skulls—10.

Skull with two fragments of femur—1.

Two skulls with a fragment of femur—1.

Skull with a few fragments of other bone—1.

Bunched burials, three with one skull, one with two skulls—4.

Two femurs together—1.

Two tibiæ together—1.

Crumbling fragments—6.

Comparatively few artifacts lay with the burials. With a few fragments of bone was mica, to which, seemingly, had been given the outline of a spearhead.

With a bunched burial were a bit of chert and a triangular fragment of pottery.

A lone skull had with it mica, ferruginous sandstone, and yellow, paint-like material, probably limonite.

With two femurs was a fragment of pottery of considerable size, and in several cases in this mound, in the same way, a part of a vessel apparently did duty for the whole.

Charcoal was associated with a number of burials. Two tibiæ lay beneath a layer 20 inches wide, 27 inches long, and 1 to 2 inches in thickness.

Singly, and apart from human bones, though it is quite possible that burials with which some of them had been had disappeared through decay, were one ham-

mer-stone, a number of pebble-hammers, pebbles, a small bird-arrowhead of quartz, and a slab of ferruginous sand-stone.

Together, with no burial at hand, were five pebbles, some showing use as hammers, and many small fragments of an undecorated vessel.

Another deposit, lying alone, consisted of one pebble; a rude arrowhead of quartzite; an astragalus of a deer; and a cutting implement of soft, clayey stone, 4.7 inches long, with one end prepared for hafting (Fig. 4).

With the exception of the fragments to which reference has been made, no earthenware was present with burials in this mound.

About 15 inches below the surface was a smoking-pipe of inferior earthenware, undecorated, with the exception of a few parallel lines on the margin of a kind of shoulder extending beyond the base of the bowl. On two sides of the rim of the bowl, and on one side of the portion intended to receive the stem, small parts have been chipped away, apparently an intentional mutilation (Fig. 5).

FIG. 4.—Implement of stone. Mound near Starke's Wharf. (Length 4.7 inches.)

FIG. 5.—Pipe of earthenware. Mound near Starke's wharf. (Height 2.25 inches.)

In fragments, near the surface, was part of another earthenware pipe of an ordinary type and of inferior ware.

Five feet from the surface, in many fragments, was an undecorated vessel which, when whole, had a globular body with a short neck.

Throughout the mound lay a limited number of sherds, some of rather inferior ware, others of excellent, yellow paste, all without shell-tempering. Decoration on them varied. There were present incised designs and decoration with red paint, and the two in combination; also incised and punctate designs. The small check-stamp is represented, as are three varieties of a pattern of complicated stamp—seemingly rather far westward for this kind of decoration. One of these complicated stamp designs, and two other sherds from this mound, are shown in Fig. 6.

One fragment of a vessel, part of a base, shows a mortuary perforation.

The mound near Starke's wharf was the only burial mound found by us on Mobile bay, if we exclude that on Simpson island, which, properly speaking, is somewhat north of the bay.

FIG. 6.—Sherds. Mound near Starke's wharf.

Shell Mound near Fish River, Baldwin County.

On the bay, about one-half mile in a northerly direction from the northern point of the entrance into Fish river, is the property of Mr. William V. Street, of Point Clear, Alabama. Adjoining the house is a shell field that has been under cultivation. In this field is a mound composed of oyster-shells with a slight admixture of small clam-shells (*Rangia cuneata*) and black loam.

This mound, roughly circular in outline, about 3 feet in height and 60 feet across the base, had thirteen holes dug into it by us; each from 3 to 5 feet in diameter at the surface, and extending to the base.

No human remains were met with.

Broken pottery was found in considerable quantity, all shell-tempered, though it was noted that the finer quality of ware contained shell pounded into more minute particles than that in the coarser variety. The decoration is incised, in the main, consisting chiefly of series of roughly parallel, encircling lines. Punctate decoration is present on some fragments of coarser ware, and a combination of line and cross-hatch on one specimen of fine paste. The small check-stamp is represented by a single fragment. Loop-handles are numerous.

One small disc, carefully cut from a fragment of earthenware, came from the mound, and two larger ones from the surface of the surrounding field.

Similar discs, made from fragments of earthenware vessels, have been met with in numbers in various regions from Canada[1] to Costa Rica.[2]

We have found imperforate earthenware discs of this kind in South Carolina, in Georgia, and in Alabama, but not in peninsular Florida, where the discoidal stone also is not found. These discs doubtless were used in some game. Mr. Laidlaw says the Crees and Salteaux employ them in a game similar to our "billy button." Hartman saw earthenware discs of this kind in use among the children of the Pipiles of Salvador, who fastened a bunch of feathers to a disc and throwing it into the air, called it "pigeon" or "little rooster."

In northwestern Florida[3] we found two earthenware discs centrally perforated, one on each side of a skull, against the bone, with a disc of sheet-copper on the outside of each of the pottery discs. Cord remaining in the copper discs showed that each had been connected with one of the earthenware discs and that the cord, passing through the lobe of the ear and fastened to the earthenware disc, which was worn behind the lobe of the ear, had kept the copper disc in place in front of the lobe. Once again, in middle Florida, we found two similar discs of earthenware with fragments of sheet-copper. Such earthenware discs, utilized to economize in the

[1] G. E. Laidlaw, "The Aboriginal Remains of Balsam Lake, Ontario," American Antiquarian, March, 1897.

[2] C. V. Hartman, "Archæological Researches in Costa Rica," Stockholm, 1901, p. 33, foot-note. See also Gerard Fowke, "Stone Art," 13th An. Rep. Bur. Am. Ethn., p. 109.
W. H. Holmes, "Aboriginal Pottery of Eastern United States," 20th An. Rep. Bur. Am. Ethn., p. 43.
Stewart Culin, "Chess and Playing Cards," Rept. U. S. National Museum for 1896, p. 709.

[3] "Certain Aboriginal Remains of the NW. Florida Coast," Journ. Acad. Nat. Sci. of Phila., Vol. XII, p. 336.

use of copper, are, of necessity, centrally perforated and form a negligible percentage of the earthenware discs that are found.

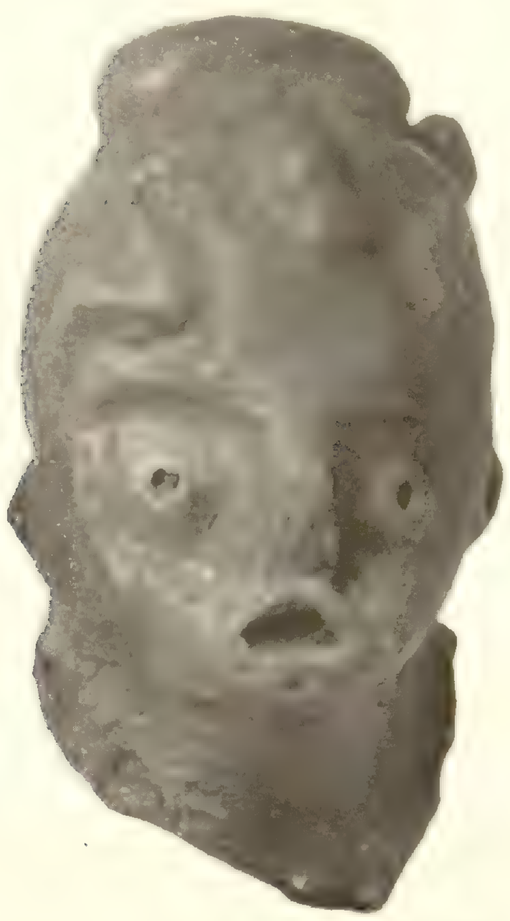


FIG. 7.—Part of earthenware vessel. Shell mound near Fish river. (About full size.)

But to return to the mound. An interesting effigy of a human head, of earthenware, originally part of a vessel, was met with in this mound (Fig. 7). The nose, broken at the end, has been carefully smoothed at the place of fracture.

A flat pebble, neatly rounded, lay among the shells. A mass of ferruginous sandstone and a small disc of the same material came from the mound; a larger disc of the same material was found on the surface of the field, as was a quartz pebble 3.5 inches in length, to which a cutting edge had been given at one end.

SHELL RIDGE NEAR BON SECOURS RIVER, BALDWIN COUNTY.

On the south side of Bon Secours river, about 1.5 miles up, at the northeast point of Oyster bay, behind the dwelling of Mr. W. R. Steiner, on whose property it is, is a ridge or mound of irregular shape and varying height, extending into adjacent fields.

Eleven excavations, from 3 to 5 feet in diameter at the opening, were carried to the base, the greatest depth being 4 feet. The ridge, where dug, was composed of black, sandy loam with a varying percentage of oyster-shells, among which were a few small clam-shells. Below the shells was a layer of black, loamy sand, free from admixture of shell; and beneath this was yellow sand, the original surface.

Fragmentary human remains were found in four places, none at a depth greater than 2 feet.

Near the fragments of a skull was a shell hair-pin with part of the shank missing through an early fracture.

Ten cannon-bones of the deer, parallel one to another, lay in a little pile about 2.5 feet from the surface.

In addition to several pebbles and masses of ferruginous sandstone, two lumps of hematite were found, very bright in color, ready to grind for paint.

The earthenware, of which many fragments were uncovered, varies greatly in quality, some fragments being strong and bearing a considerable polish. The ware is shell-tempered in nearly every instance, though in several specimens the eye fails to detect evidence of shell, and in one fragment sand-tempering is plainly visible. The ware, when decorated, bears the small check-stamp; incised designs, including part of the human hand; punctate markings; and, in one specimen, raised decoration. A selection of sherds from this place is shown in Fig. 8. Two small discs,

FIG. 8.—Sherds. Shell deposit near Bon Secours river.

made from fragments of earthenware vessels, were found. One of these, shown with the sherds, has a perforation near the center from which five radii extend on one side of the disc and six on the other.

Mounds on Seymour's Bluff, Baldwin County.

Along Seymour's bluff, which is near the southeastern end of Mobile bay, near the water, are seven mounds on properties of Mr. Owen Roberts, of Mobile, and Messrs. William D. Todd and J. W. Nelson, of Gasque, a nearby settlement. These mounds, all of sand more or less blackened with organic matter, were probably erected for domiciliary purposes, as an exhaustive examination of one, and a careful examination of five others, yielded only a few animal bones, one rude arrowhead, and some fragments of earthenware.

One mound, used as a cemetery in recent times, was only casually investigated by us. It resembles the others outwardly and probably belongs to their class.

The westernmost mound, to which the principal examination was given, had a height of 5.5 feet with a basal diameter of 120 feet. Of the remaining mounds, some were slightly larger than this one, some smaller.

The earthenware from these mounds, including parts of shallow platters, when decorated, bears the small check-stamp almost exclusively, though in one instance the head of a duck, in relief, is present. None of this ware, so far as noted, has an admixture of shell.

As these mounds indicated the presence of a considerable population in early times, special attention was devoted by us to a search for a cemetery. Much of the level ground nearby was carefully sounded with iron rods, and adjacent woods were scoured in the endeavor to locate undulations in the ground, which sometimes mark the presence of cemeteries. Our efforts were not rewarded.

Shell Bank, Strong's Bayou, Baldwin County.

Going westward from Seymour's bluff along the shore of the bay a distance of perhaps 1.5 miles, shell fields are encountered with deposits of shell, increasing in bulk until the culmination is reached on the shore of Strong's bayou, in a mass of oyster-shells known as Shell Bank, the property of Mr. J. C. Nelson, of Gasque. All along the bay-side the wash of water has laid bare a section of shell deposit, which was carefully examined by us. No human bones were seen, but a number of fragments of pottery lay in the shell, while other sherds, some water-worn, were upon the shore. If the small check-stamp is represented in the decoration of the earthenware in this shell deposit, some of which is excellent and bears incised and punctate markings, as shown in Fig. 9, it was not noted by us. Only shell-tempered ware was seen. Here, in two respects, we note a contrast between the earthenware of the shell deposit and that of the neighboring domiciliary mounds of sand.

Two discoidal stones which, no doubt, had fallen from the shell bank, lay below it on the beach.

Cedar Point, near the southwestern extremity of Mobile bay, has a considerable shell deposit which was not dug into by us.

We were unable to locate any aboriginal remains on the western side of Mobile bay, though careful inquiries were made on Fowl river and on Dog river.

FIG. 9.—Sherds. Shell deposit, Strong's bayou.

MOUND ON BOTTLE CREEK, BALDWIN COUNTY, ALA.

This locally-famous mound, considerably north of Mobile bay, properly cannot be included among aboriginal remains of that bay; but as it should not be passed without notice, a description of it will be given here.

The mound, on property of Mr. B. F. McMillan, of Stockton, Alabama, is in a cultivated field about one-quarter mile from the western bank of Bottle creek, at a point about four miles up stream. Bottle creek connects Middle river with Tensas river.

The mound, 46.5 feet in height, oblong with rounded corners, has a basal length E. by N. and W. by S. of 306 feet. Its width is 251 feet. The summit plateau is 100 feet in length and 42 feet wide. Judging from the shape of the mound, it belongs to the domiciliary class, and this belief was strengthened by the examination of a considerable excavation made by former diggers on the western side of the mound. So far as this digging shows, the mound is of clay. No excavation was attempted by us.

Surrounding the mound had been a dwelling-site, and the ploughed surface showed hammer-stones, fragments of chert, and bits of pottery, the last including a bird-head ornament from a vessel, 5 inches in height.

A sprinkling of small clam-shells (*Rangia cuneata*) was observable over the ground.

Near the mound and in the swamp were circular elevations and ridges, all of clay with the exception of one which was of sand and clay. Careful examination showed these to have been dwelling-sites containing the usual debris and, in one instance, a toy-bowl of earthenware, about an inch in diameter. Within the sites and on the surrounding surface was fairly good earthenware, some of the fragments being rather rudely decorated. Nearly all were shell-tempered, though in one instance, at least, the tempering was of coarse sand. One of the well-known earthenware discs, cut from a fragment of a vessel came from a dwelling-site. This disc bears what may have been an interesting, incised decoration made after the excision of the disc, but unfortunately, it is too much weathered to determine the character of the design.

One circular elevation, about 5 feet high and 100 feet in diameter, had near the surface a flexed burial, presumably intrusive. In addition, were two recent graves with skeletons at full length, near which were iron nails and fragments of wooden coffins.

MOUNDS AND SITES INVESTIGATED ON MISSISSIPPI SOUND.

Shell Deposit on Dauphin Island, Mobile County, Alabama.

Dauphin island, part of which is bordered by Mobile bay, and part by Mississippi sound, of which it is the southeastern boundary, is mainly a narrow strip of bare sand. At its eastern end is a considerable aboriginal deposit of shells, mainly of the oyster.

Some digging by us yielded fragments of earthenware, some shell-tempered, others not. The ware, when decorated, resembles that of Mobile bay. Loop handles and effigies of heads of birds are present. A selection of sherds from this island is shown in Fig. 10.

No human remains were found, though in the great shell-heaps of this place, burials may well have escaped us.

Mounds near Coden Bayou, Mobile County.

Coden bayou, a part of Mississippi sound (where work was begun by us after leaving Mobile bay), and the nearby town of Coden have their name from an abbreviation of *Coq d'Inde*, "turkey," the former name of the bayou, which name it still bears on the Government chart.

Four small mounds, one belonging to Mr. Henry Klass, Jr., of Mobile, three to Mr. E. F. Long, of Coden, were investigated by us near this place without

FIG. 10.—Sherds. Shell deposit, Dauphin island.

material result, no human remains and almost no pottery being found. These mounds, all of which had been considerably dug into previous to our visit, presumably belong to the domiciliary class.

MOUNDS NEAR BAYOU BATRE, MOBILE COUNTY.

About one mile north of the bayou, on the western side, is a property known as the Tate place, belonging to Messrs. William E. Gordon and William Vizard, of Mobile. On this property, which is in sight from the water, are two mounds, one of which, of clay, 6 feet in height and 80 feet across its circular base, had undergone much digging previous to our visit. A careful examination of this mound yielded no human remains and but one small fragment of earthenware.

Nearby is the other, a somewhat smaller mound, also domiciliary.

MOUND NEAR MARY WALKER BAYOU, JACKSON COUNTY, MISSISSIPPI.

Mary Walker bayou enters West Pascagoula river not far from the sound. On the south side of the bayou, near its mouth, is the residence of Mr. David Saucier. About 100 yards in a northwesterly direction from the house is a mound of sand, of circular outline, 3.5 feet in height and 56 feet in diameter of base. A thorough investigation showed this mound to have been domiciliary in character.

Mounds near Graveline Bayou, Jackson County.

Beginning not far from the eastern side of Graveline bayou, back from the bluff that overlooks the sound at this place, are seven mounds of sand, all within three-quarters of a mile from the bayou, on property of Mr. J. I. Ford, of Scranton, Miss. All these mounds are circular in outline with the exception of the largest, which is oblong in horizontal section, about 6 feet in height, with basal diameters of 81 feet north and south and 93 feet east and west, the sides almost corresponding to the cardinal points of the compass. The summit plateau of this oblong mound is 38 feet north and south and 50 feet east and west. Each of the seven mounds was carefully examined by us without discovery of human remains. A few bits of earthenware were met with, only one of which bears decoration.

Mounds near Belle Fontaine Point, Jackson County.

About two miles in a northwesterly direction from Belle Fontaine point are three mounds on property of Mr. S. G. Ramsey, of Fort Bayou, Miss. One of these mounds, used as a modern place of burial, was not investigated by us, but as it resembles the other two, both small, which investigation showed to be domiciliary, it is doubtless of the same kind.

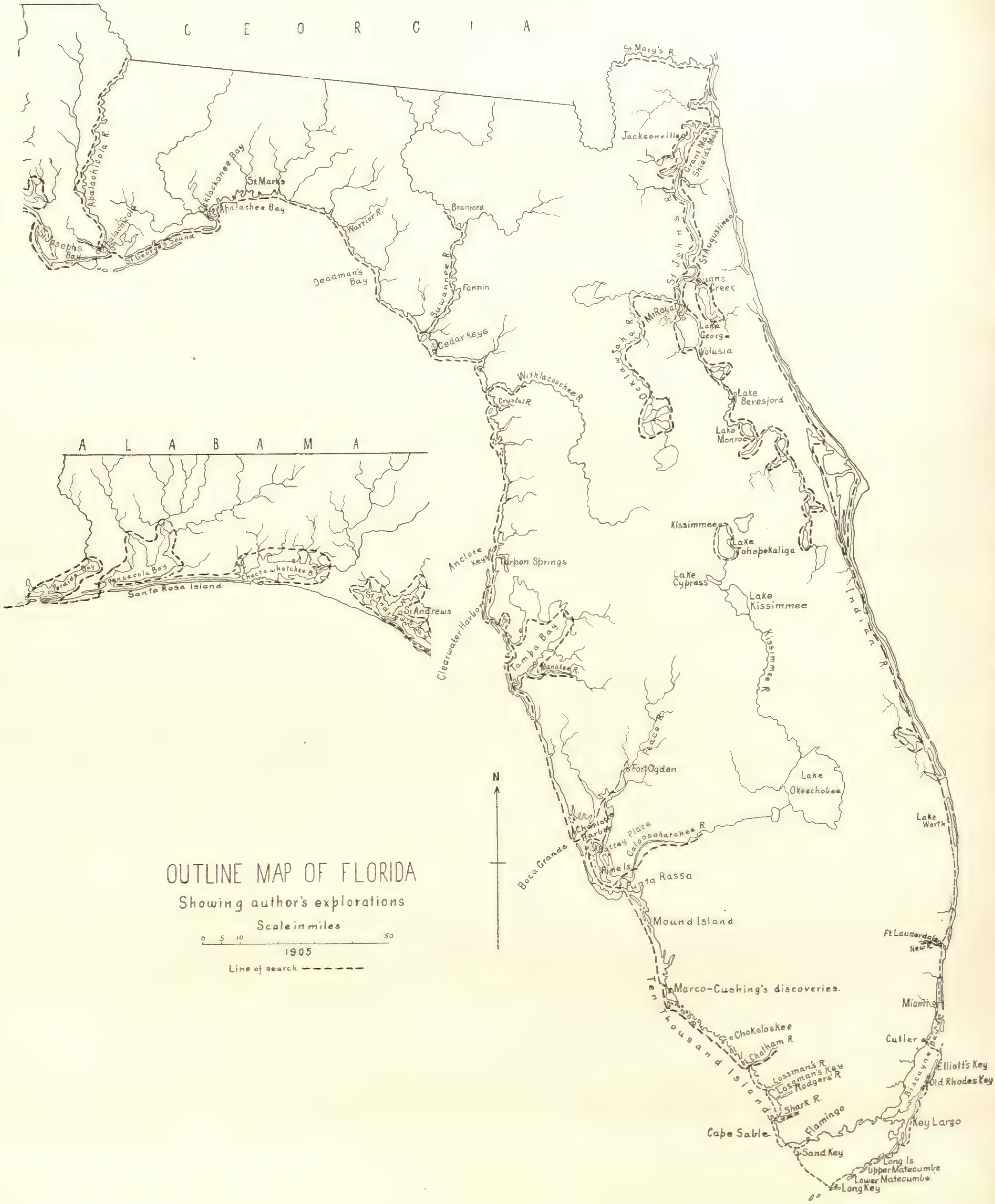
Mound on Tchu La Cabawfa River, Harrison County, Miss.

This mound, said to be on land the ownership of which has reverted to the State, is about six miles in a northerly direction from Biloxi, though much farther if reached by water. It stands about two hundred yards from the eastern bank of the Tchu la Cabawfa river, and about one-half mile above Hawley's bluff, which is on the opposite side of the river.

The mound, in pine woods, is of clay; its outline rounded but irregular. Its basal diameters are 450 feet N. and S. and 290 feet E. and W. Its height is 11 feet, though if measured from points whence material for its building has been taken, the elevation is somewhat greater.

This mound, evidently domiciliary, was dug into by us to a reasonable extent, without material result, for the purpose of ascertaining whether superficial burials had been made.

As our ill-success on Mississippi sound had been so uniform, and as the two agents sent by us in advance to locate mounds had failed to find any west of Biloxi, our investigation of the aboriginal remains of the sound was abandoned at that point, as we have said in our introduction to this report.



OUTLINE MAP OF FLORIDA

Showing author's explorations

Scale in miles

0 5 10 50

1905

Line of search ------

MISCELLANEOUS INVESTIGATION IN FLORIDA.

By Clarence B. Moore.

Our archæological exploration in Florida, during the season of 1904, was unsatisfactory to a certain extent; but as it has ever been our wish to let no investigation of ours pass unrecorded, we give a brief description of the season's work.

THE KISSIMMEE REGION.

The Kissimmee river, leaving the southern extremity of Lake Tohopekaliga, on which is the town of Kissimmee, flows through Cypress Lake and Lake Kissimmee, and continues in a southerly course to Lake Okeechobee. A canal connects the southwestern side of Lake Okeechobee with Caloosahatchee river, which empties into San Carlos bay, an arm of the Gulf of Mexico. These geographic features are shown on maps of Florida, and are presented on the outline map accompanying this report, which shows also the scope of all our archæological work in that State.

A few years ago it was possible, by the aid of certain canals, to make a journey by water, in a steamer of light draught, from Lake Tohopekaliga to the Gulf. Recently, however, the canals had been neglected, and an extensive growth of waterweeds, miles in extent, had formed in Kissimmee river north of Lake Okeechobee; in addition, a heavy dam[1] had been built across Caloosahatchee river, somewhat south of the lake. It was impossible, therefore, at the time of this exploration, for us to take our large, flat-bottomed steamer from the Gulf coast, where she lay, into the Kissimmee region.

Mr. J. S. Raybon, captain of our steamer, an expert in locating mounds, with a companion familiar with the territory, carefully traversed the region between Lakes Tohopekaliga and Okeechobee, inclusive. The report, however, was discouraging. Nowhere was there news of the discovery of earthenware vessels, and such few objects as were reported to have been found by the inhabitants were mainly of European make, and, perhaps, intrusive.

Lake Okeechobee was reported to be surrounded by marsh, and to be without mounds. Nevertheless, we determined to explore the region, if possible, and for this purpose chartered a small steamer which took in tow a flat-boat on which quarters had been built for the use of our colored mound-diggers.

After investigation of the mounds of Lake Tohopekaliga, which was practically without positive result, as the appended account will show, a severe accident occurred to our steam-boiler, which would have rendered the boat useless for a considerable time. No other boat being available, the investigation of the region was therefore abandoned.

[1] Since removed.

MOUNDS OF LAKE TOHOPEKALIGA, OSCEOLA COUNTY.

Mound near Kissimmee.

In a prairie, near the lake-shore, about one mile in a SSW. direction from the town of Kissimmee, on land of Mr. Walter Bass, Sr., of Kissimmee, is a mound, circular in outline, that has been much pawed and trampled by cattle. Its present height and diameter of base are 3 feet and 80 feet, respectively. It is built of sand, as are all the mounds of Lake Tohopekaliga.

Twelve excavations, each about 3 feet square, extending to the base of this mound, resulted in the finding of one arrowhead of chert, a fragment of earthenware bearing the ubiquitous small check-stamp, and several sherds of most inferior ware, each about .5 inch in thickness, with decoration of incised lines. No human remains were found. The mound was doubtless domiciliary.

Lanier Mound.

Situated in pine woods, about 6 miles in a southerly direction from the town of Kissimmee, on property of Mr. J. M. Lanier, living near by, is an artificial ridge of white sand extending almost due north and south. This ridge is 250 feet long and 90 feet in maximum basal breadth; its greatest height is 12 feet 3 inches. Previous to our visit, considerable digging had been done in this mound by persons in some cases known to the owner. No discoveries were reported by these persons.

Although the Lanier mound had every appearance of having been constructed for domiciliary purposes, and the lack of success of previous diggers tended to bear out this idea, three excavations were made by us, each 10 feet square and extending to the base of the mound. One of these was in the southern part, where the mound reached its greatest height; another, of almost equal depth, somewhat more to the north, and the third toward the northern extremity, where the height of the mound was about 8 feet.

In one excavation no relics or remains were encountered. In one was a small deposit of charcoal, and three bits of inferior, undecorated earthenware, found separately.

In the second excavation, at a depth of about 20 inches, was a "celt," with fragments of a human pelvis and parts of a femur and a humerus. About 3 feet distant, at the same level, was a human skull without the lower jaw.

Two and one-half feet down, in the same excavation, was a "celt," almost oblong in outline, with a bit of shell and two fragments of bone, too small for identification.

In our opinion this also was a domiciliary mound and the "celts" and human remains were intrusive.

Mounds near Brown's Landing.

Brown's landing is about one mile south of Edgewater, on the southwestern shore of Lake Tohopekaliga. A mound is situated in pine woods about 2 miles in a southwesterly direction from the landing, in sight from the public road, on prop-

erty of Messrs. H. M. Pfann & Co., of Campbell, Fla. It is circular in outline, 5 feet 4 inches in height and 65 feet across the base. It has been dug into to so great an extent that after slight excavation it was abandoned by us. Various fragments of human bones were met with, and a number of sherds of very inferior ware, all undecorated save one upon which was a certain amount of red pigment. In addition, a single bead of blue glass, about the size of a buckshot, lay alone in the sand.

About three-quarters of a mile southwest of the mound just described, in open pine woods, in full view from the public road, is a mound of white sand, 9 feet 4 inches high and 150 feet across the circular base. This mound, which had every appearance of being domiciliary, was dug into superficially by us in many places, but no human remains or artifacts were encountered.

About three-quarters of a mile in an easterly direction from the mound just described is another, flat and irregular, evidently domiciliary.

Between these two mounds, though not directly connected with them, are two parallel artificial ridges, about 300 yards apart, extending about NW. and SE., and estimated to be from 3 to 5 feet in height. One is 200 yards, the other 300 yards, in length, approximately. These embankments do not run parallel to an imaginary line connecting the mounds, but cross it and seem to terminate in two small swamps.

The two mounds and ridges are on property belonging to Messrs. H. M. Pfann & Co.

Mound near Frier Cove.

This mound, on property of Mr. Stephen C. Partin, of St. Cloud, Fla., lies about one mile in a southeasterly direction from the cove near the SE. end of the lake. It had been long under cultivation, and, in consequence, was widely spread by the plow. Its height, at the time of our investigation, was 3 feet; its basal diameter, 83 feet. It was pitted and trenched in all directions by us, but yielded only a few, small fragments of human bone and a bit of undecorated pottery.

Mound near Lee's Landing.

Lee's landing is on the eastern shore of Lake Tohopekaliga, and the mound is situated about half a mile northwesterly therefrom, in a beautiful orange grove on the estate of Judge George F. Parker, of Kissimmee. Greatly spread by years of cultivation, its present height is only 2 feet. Its diameter, difficult to determine through irregularity of outline, may be considered about 60 feet.

This mound was carefully excavated by us in parts free from roots of orange trees. Toward the center, badly decayed, was a full-length skeleton on its back, and a second skull, without mandible, lying near the pelvic part. Near this skull was a carefully-made arrowhead or knife, of chert. Nearby were a crushed skull, and parts of two skeletons which, seemingly, had been mutilated by some modern excavation. No earthenware was found.

Mound near McCool's Landing.

McCool's landing is somewhat north of Lee's landing on the eastern lake shore. The mound, on hammock land, on property of Mr. W. A. McCool, of Beaver Falls, Pa., is about half a mile in an ESE. direction from the landing. It is 15 inches in height and 26 feet in diameter, and is thickly covered with small oaks and scrub-palmetto. Numerous carefully-made excavations yielded nothing.

Mound near St. Elmo Landing.

St. Elmo landing is near the NE. extremity of the lake. The mound, on property of the United Land Co., of Philadelphia, is about one-quarter mile in an easterly direction from the landing. Its height is 3 feet, its diameter 75 feet.

Twelve excavations, each about 3 feet square, yielded three bits of undecorated pottery. Presumably the mound was domiciliary in character.

PEACE CREEK AND CHARLOTTE HARBOR.

Leaving the Kissimmee region, we transferred our crew and the colored diggers to our steamer which lay at Fort Ogden, on Peace creek which empties into Charlotte Harbor (see outline map).

The lower part of Peace creek, previously investigated by our agents, was searched by us without discovering aboriginal mounds worthy of extended investigation.

Charlotte Harbor was examined a second time, a former visit having been made in the season of 1900, without material result. A number of reported mounds turned out to be shell-heaps only.

Mound near Hickory Bluff, De Soto County.

The remains of a mound near Hickory Bluff yielded to us only a few fragments of pottery of inferior grade, bearing crude line and punctate decoration, a selection of which is shown in Figs. 1, 2, 3.

Mound in Gasparilla Sound, De Soto County.

On a key believed to be nameless, the first large key north of Boca Grande Pass, in Gasparilla sound, were the remains of a sand burial mound almost demolished by treasure seekers, according to report. A small remaining part, dug down by us, contained the considerably decayed remains of from fifteen to twenty skeletons, some loosely, some closely, flexed; but these burials yielded only a single skull worthy of preservation (Acad. Nat. Sci. catalogue, No. 2227).

The sole artifacts found with the skeletons were three shell drinking-cups,—one imperforate, two with basal mutilation, with one burial; and two perforate ones with another burial. A number of fragments of inferior, undecorated ware lay where former diggers had left them. Two fragments of considerable size, found by us, have rude decoration, and on one is a loop-shaped handle (Figs. 4, 5). Sand tinged with hematite lay in various parts of the mound.

FIGS. 1, 2, 3.—Sherds. Mound at Hickory Bluff. (Two-thirds size.)

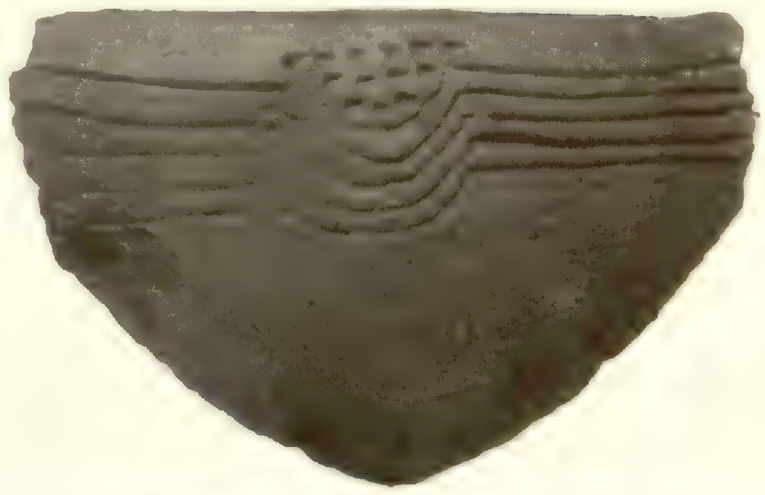


FIG. 4.—Sherd. Mound in Gasparilla Sound. (Half size.)

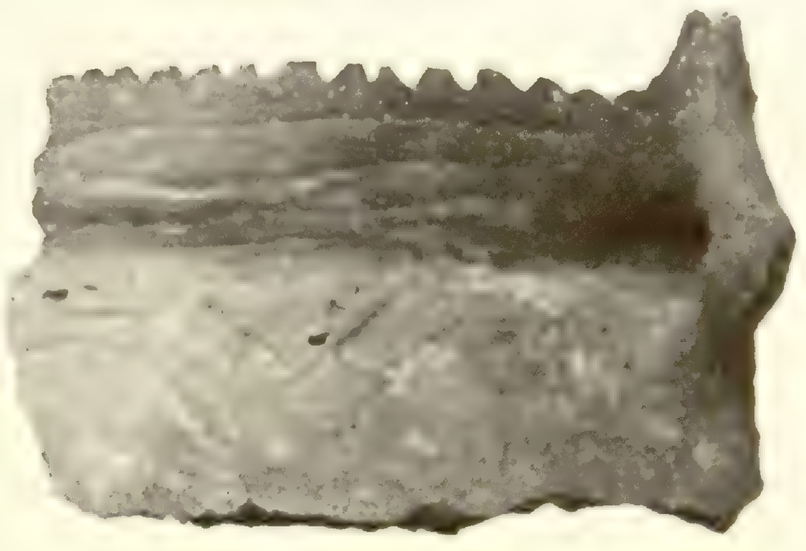


FIG. 5.—Sherd. Mound in Gasparilla Sound. (Half size.)

THE SOUTHERN FLORIDA COAST.

The remainder of the season of 1904 was devoted to exploration of the coast of southern Florida and adjacent islands. We had explored a part of this region in the season of 1900, when we investigated from a point north of Tampa bay southward to Chatham river (see outline map). A report of this work is given in "Certain Antiquities of the Florida West-Coast," Journ. Acad. Nat. Sci. of Phila., Vol. XI.

This season (1904), beginning at Charlotte Harbor, we continued southward through Pine Island sound, Estero bay and along the Gulf coast to the island of Marco, next to the northernmost key of the Ten Thousand islands. From Key Marco our course lay through the keys, including Chokoloskee Key and Lossman's Key, and along the coast to Cape Sable, the southern boundary of the Ten Thousand islands.

Rounding Cape Sable and visiting points of interest on the mainland and

investigating various keys, we continued eastward, then northward, to Miami; to Fort Lauderdale on New river, where the Everglades were visited; and finally, to Lake Worth, which was the southern limit of our work during the season of 1896.

As a result of this part of our journey of the season of 1904, we formed certain conclusions, and fortified others which we had previously expressed in print, namely:

(1) That while the shell deposits of the southwestern coast of Florida are of great interest as monuments of the aborigines, their contents offer little reward to the investigator.[1]

(2) That the sand mounds of the southern Florida coast were built mainly for domiciliary purposes, and that such as contain burials yield but little pottery, whole vessels being practically absent.

(3) That these burial mounds contain but few artifacts of interest[2] and that such artifacts as are met with in the smaller ones, and superficially in the larger ones, are often of European origin, marking a strong contrast with the mounds of the northwestern Florida coast and of St. John's river.

(4) That the failure of the aborigines to place earthenware with the dead, in mounds along the southern Florida coast, did not arise through lack of its possession, but rather that the custom of doing so did not obtain there. Fragments of earthenware, though fewer in number and of far inferior quality on an average than in central and northern Florida, are met with along the southern Florida coast. Similarly, along the whole eastern coast of Florida, entire vessels seem to be absent from the mounds,[3] though inland, in the northern part of the peninsula, at least, whole vessels are fairly abundant.

(5) That while the muck, *i. e.*, mud and organic matter, which fills the canals and small artificial harbors of the Ten Thousand islands, in one instance yielded so rich a reward to Mr. Cushing's labors, it seems likely, as Mr. Cushing believed, that the objects of wood found by him at the town of Marco, Key Marco, were present there through some particular cause. Certain it is that extensive digging in the muck by Mr. Cushing and by ourselves in other localities, yielded nothing of wood, and that ditch-making and the like by the inhabitants of the Ten Thousand islands have brought to light, so far as we can learn, almost nothing of that material. An attempt to duplicate a discovery such as Mr. Cushing's would resemble a search for a needle in a hay-stack.

We shall now describe certain work in detail.

[1] Incidentally it may be said that the great shell deposit on Bullfrog creek, Tampa Bay, described and figured in the Smithsonian Report for 1879, has since been entirely demolished to furnish material for streets of the town of St. Petersburg. It was reported that in the removal of the deposit nothing of interest was found.

[2] It is said that the well-known mound at Miami, when demolished, yielded nothing except human bones.

[3] "Mound Investigation on the East Coast of Florida," by Clarence B. Moore, Phila., 1896. Privately printed.

The late Andrew E. Douglass spent years in investigating the mounds of the eastern coast, from St. Augustine in the north to Miami in the south, without finding an entire vessel.

Mound on Pine Island, Lee County.

Pine Island is a narrow island about fifteen miles long, just south of Charlotte Harbor.

About three miles below the northeastern extremity of Pine Island, just off shore, is a key[1] about three acres in extent, called "Indian Old Field," which is an aboriginal shell deposit with a shell mound upon it.

About three-quarters of a mile in a WNW. direction from the shell key, on Pine Island, was a burial mound of sand, slightly over 5 feet in height and 60 feet across the base. The mound was away from the solid ground, on what is known as a sand-spit, *i. e.*, territory not usually covered by tides, but subject to overflow during unusually high ones,—a curious spot to choose for a place of burial when solid ground was so near.

Near this burial mound is the eastern end of the aboriginal canal that extends across Pine Island, a distance of about two miles, and ends at the huge deposits of shell and mounds of sand, formerly known as the Battey Place,[2] but now called Pineland, on the western shore of the island.

The mound, then on property of the late J. H. Kreamer, Esq., of Philadelphia, was partly investigated by us in the winter of 1900.[3] During this investigation there were found burials at thirty-eight points, loosely-flexed, closely-flexed, and several masses of disconnected bones; also aboriginal disturbances.

With the burials were three "celts" of iron or of steel; glass beads, in three instances; two tubular beads of sheet-silver, with overlapping edges; one kite-shaped pendant of thin sheet-silver, decorated with a cross *repoussé*; a handsome lancehead of hornstone, 4 inches long; a lancehead of chert; two arrowheads of chalcedony; a tooth of a fossil shark, with a perforation. At the beginning of the excavation, at the northeastern side of the mound, were many fragments of pottery belonging to different vessels, placed thickly together; also several shell drinking-cups, and a number of conch-shells (*Fulgur perversum*).

In the winter of 1904 the mound was revisited by us and completely excavated, with the kind permission of Mr. and Mrs. Ferdinand Harrsen, living near-by, who had acquired the property since the former investigation.

This mound, built on lime-rock, was of gray sand except near the base where the sand was black through admixture of organic matter. In this black material, which increased in thickness from a few inches at the margin to about eighteen inches at the center, lay a number of burials, many flexed, some to the left, some to the right. In parts of the base was what seemed to be an inextricable confusion of burials; and the badly decayed condition of the bones and the presence of water, at times, made determination of the form of burial impossible. Nevertheless, it was certain that among the burials were scattered disconnected bones, sometimes singly,

[1] Key, from Spanish *cayo*, "rock," "shoal," "island."

[2] Described by Mr. Frank Hamilton Cushing, "Preliminary Report on the Exploration of Ancient Key Dweller Remains on the Gulf Coast of Florida," Proceedings of the American Philosophical Society, Philadelphia, Vol. XXXV, No. 153, p. 13 *et seq.*

[3] Described in our "Certain Antiquities of the Florida West-Coast," Journ. Acad. Nat. Sci. of Phila., Vol. XI, p. 362 *et seq.*

sometimes in masses. In other parts of the basal area of the mound were single flexed burials, as well as bunched burials with sometimes a single skull and sometimes several crania. There were, also, two closely-flexed skeletons in graves below the base, and among the skeletons at the base, which were somewhat loosely flexed as a rule, were two in a state of close flexion. In the body of the mound, but showing no sign of being intrusive, were two flexed burials and many bunched burials.

As the burials were numerous in this mound, and often encroached one upon another, it was deemed best to score singly such burials as were surely flexed and to keep a tally of the skulls found in bunched burials and where, through commingling of interments, it was impossible to say just what the form of burial had been.

There were, then: four closely-flexed burials and thirty-seven burials loosely flexed; one skeleton with the lower part cut off by an aboriginal grave. In addition, 177 skulls were found. Thus, during our second investigation, burials representing 219 individuals were unearthed.

The bones, as a rule, showed considerable decay. But three skulls were saved in good condition; these, preserved at the Academy of Natural Sciences of Philadelphia, are numbered 2228, 2229 and 2230, respectively.

This mound, following the rule among mounds of southern Florida, where earthenware plays but a small part among objects placed with the dead, contained but one whole vessel—a rude, undecorated bowl, about 7 inches in diameter, imperforate as to the base. This bowl, seemingly, was not associated with human remains.

There were also in the mound, scattered here and there, various sherds, as well as parts of vessels each represented by three or four fragments. In all cases, save one, the ware is inferior.

FIG. 6.—Sherd. Mound on Pine Island. (Half size.)

As might be expected in earthenware found so far south in the peninsula, but little decoration is present on the pottery from this mound. Three or four fragments of one vessel show a roughly executed, incised and punctate design (Fig. 6). The ubiquitous small check-stamp was three times encountered.

One fragment of a rim showed a series of notches, and in two cases the loop-handle decoration was met with, probably from a vessel or vessels similar to one shown in Plate CX, "Twentieth Annual Report of the Bureau of American Ethnology."[1]

With the burials along the base of the mound no implement or ornament of European origin was found, but a slab of pine wood from the basal part of the mound, showed a clean cut which could have been made only with an axe of metal.

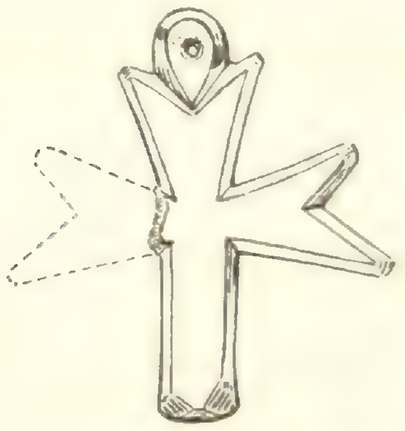


FIG. 7.—Glass cross. Mound on Pine Island. (Full size.)

FIG. 8.—Object of earthenware. Mound on Pine Island. (Full size.)

Also on the base were found: a number of hammer-stones, some large; a bit of stone worked to a cutting edge; a thin, triangular fragment of limestone, above a burial, about 1.5 feet in length as to its sides; a small fossil shark's tooth, near a skull; a number of conch-shells (*Fulgur perversum*); drinking-cups made from the same variety of shell; one *Fulgur* with ground beak, and with body-whorl removed, probably used as a chisel. There was also an implement wrought from the heavier variety of *Fulgur perversum*, with part of the body-whorl removed and a hole below the shoulder, opposite the opening, to allow a handle to pass through at right angles, and another hole above this one and above the shoulder to facilitate the lashing of the handle. That part of the shoulder of the shell which is between these holes is greatly worn by the material used for attachment. The beak is much ground and splintered by use. A description of many shells used as implements by aborigines of southern Florida is given in our "Antiquities of the Florida West-Coast."[2]

Also at the base of the mound were found: a large clam-shell; a shell identified by Dr. H. A. Pilsbry as *Collista nimbosa*, lying beneath the shoulder of a skeleton; and a number of conchs, wrought to a certain extent but not sufficiently to show what their use had been. These conchs, all of which belong to the more delicate variety, may have been drinking-cups partly completed.

With or near burials in the body of the mound were a single glass bead, a considerable number of small glass beads, one large hammer-stone, and one sandstone hone.

There were also, variously distributed with burials, five axes of the type obtained by aborigines from early white traders; three pairs of scissors; two broad chisels; three knives; one pruning knife; one chisel or caulking-knife; one implement 28 inches long, square in cross section, about .75 of an inch in diameter, pointed at one end. This implement, of iron or of steel (as were all the foregoing), presumably intended for a drill, may have seen service as a spear, when hafted.

[1] "Aboriginal Pottery of Eastern United States," by W. H. Holmes.
[2] Journal of the Academy of Natural Sciences of Philadelphia, Vol. XI.

Three beads of sheet-silver, with overlapping edges, somewhat less than 2 inches, 1.25 inch, and 1 inch, in length, respectively, came from various parts of the mound, with or near burials, as did part of a glass cross (Fig. 7); a fragment of an earthenware vessel, about 1.5 inches in length, verging on ovoid in outline (Fig. 8), and a rude though interesting pendant of glass, showing aboriginal work on European material (Fig. 9).

With a burial was a concavo-convex pendant of thin sheet-silver, about 5 inches long, with two holes at one end for suspension (Fig. 10).

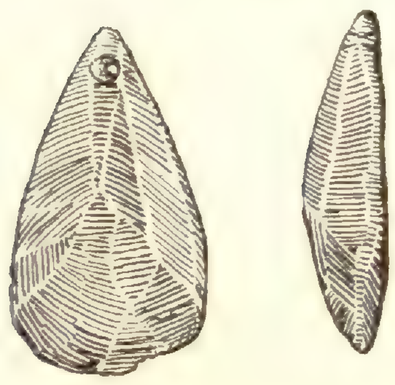


FIG. 9.—Pendant of glass. Mound on Pine Island. (Full size.)

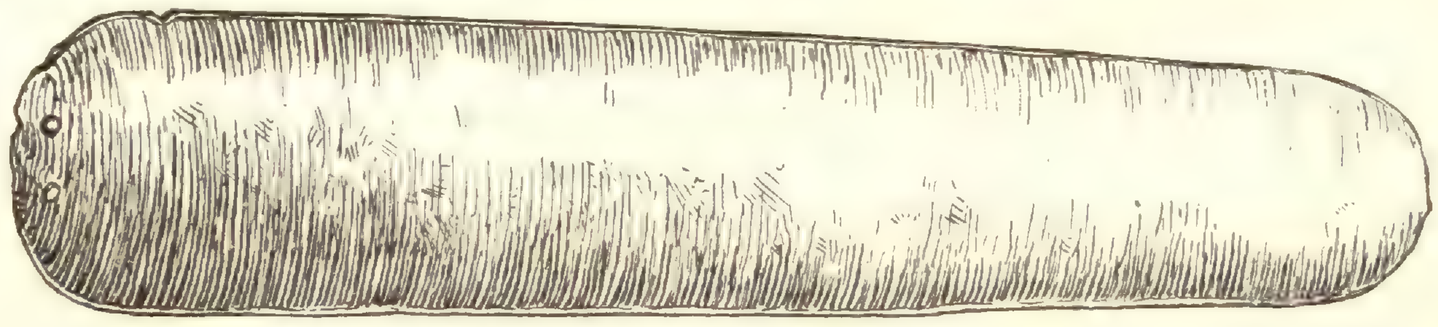


FIG. 10.—Ornament of sheet-silver. Mound on Pine Island. (Full size.)

We have here a good example of a mound distinctly post-Columbian, containing many objects as to the European provenance of which no doubt can be entertained.

MOUND NEAR PUNTA RASSA, LEE COUNTY.

About two miles in a northerly direction from Punta Rassa, in the heart of a mangrove swamp, a mound was reached by rowing up Shell creek a short distance, and then going into the swamp about 300 yards, from the northern side of the creek. The aid of a guide is necessary. The mound, which was kindly placed at

FIGS. 11, 12, 13.—Sherds. Mound near Punta Rassa. (About full size.)

our disposal by the owner, Mr. George R. Shultz, of Punta Rassa, is of pure, white sand. The outline of the base is circular, save at one place, where a sort of flat projection extends into the swamp. The mound is 14 feet 6 inches in height. If

present conditions existed when the mound was built, the sand used in its making must have been carried some distance, perhaps from the creek, as the black muck of the swamp surrounds the mound on every side.

The basal diameter of the mound is hard to determine. Either much sand has washed from the mound, forming a deposit at its base, or a sort of platform was built to serve as a base. The diameter, excluding this deposit or platform, is about 90 feet.

A great hole had been dug into the center previous to our visit.

Throughout the surrounding swamp are shell fields and numerous causeways of shell, extending in all directions. A narrow causeway, with steep sides, about 90 yards long, leaving the northwestern part of the mound, connects it with a large shell field. Another causeway extends from the same part of the mound at a different angle toward the same shell deposit, which, however, it fails to join. A third causeway leads from the mound toward Shell creek, but does not meet it.

A considerable amount of digging by us yielded 7 flexed burials, from 1 foot to 5 feet in depth. No artifacts lay with them, though previous diggers report the finding of many glass beads, and one such bead was met with by us in sand previously thrown out.

A small number of sherds were found, two or three of which are of excellent ware. Several are decorated with the small check-stamp, and others have incised and punctate decoration of inferior execution (Figs. 11, 12, 13, 14).

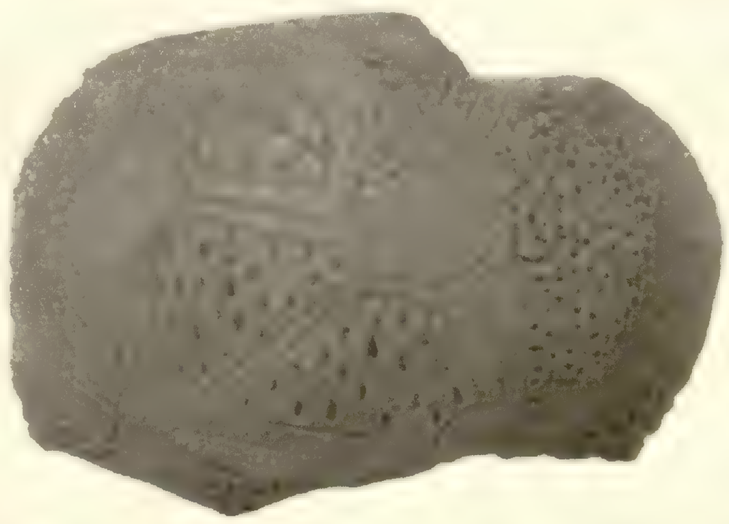


FIG. 14.—Sherd. Mound near Punta Rassa. (Half size.)

MOUND ISLAND, ESTERO BAY, LEE COUNTY.

This interesting key known as Mound Island, described in a former report,[1] was again visited by us. We learned from Mrs. F. M. Johnson that nothing of importance had been recovered since our previous visit, either from the shell deposits or from the famous sand mound which has yielded so many objects of European manufacture. Mrs. Johnson kindly had saved for us two bird-head decorations which had belonged to earthenware vessels, somewhat similar, though inferior, to those described in our former report as coming from Goodland Point, Key Marco, which also are referred to by Professor Holmes.[2]

MARCO, KEY MARCO, LEE COUNTY.

The Island of Marco (see outline map), otherwise known as Key Marco, is, as we have said, next to the northernmost key of the Ten Thousand islands, a group of keys bordering the southwestern Florida coast for a distance of about 70 miles in a straight line.

[1] "Certain Antiquities of the Florida West-Coast."

[2] "Aboriginal Pottery of Eastern United States," W. H. Holmes, 20th Annual Report of the Bureau of American Ethnology, p. 128.

The town of Marco, at the northern end of the island, is, as previously mentioned, where Mr. Cushing made his great collection of aboriginal objects, mainly of wood. These objects, as the reader is aware, lay in muck which forms the bottom of a small artificial basin in the shell deposit, formerly connected by a short canal with the neighboring water.

It is needless here to dwell on Mr. Cushing's archæological discoveries at Marco, the most important that have been made in Florida, as his preliminary report,[1] which his untimely end rendered final, gives a sufficiently clear description.

There is one point, however, which archæologists would gladly know: How did this great assemblage of objects come to be in this particular spot? Artificial harbors, basins and canals abound among such keys of the Ten Thousand islands as were selected by the pile-dwellers as places of residence, yet, as we have said, no collection of objects has been met with elsewhere in the muck, though considerable digging has been done by explorers and by modern inhabitants of the keys.

Objects of wood dropped or thrown ceremonially, into water, would float; and it is hardly likely that, at periods of low water, objects were buried ceremonially in the muck. It was Mr. Cushing's belief, personally expressed to us, that the objects found by him, contained in houses or in a temple on the banks of the court, or basin, had been forced down by some cataclysm of nature and subsequently held in the muck. This would seem to be a reasonable explanation, and especially so as Mr. W. D. Collier, of Marco, through whose kind permission the basin was examined, informs us that in the year 1873 a tidal wave, brought on by a hurricane, did much damage at Marco and submerged the muck-pond in which the objects were found by Mr. Cushing.

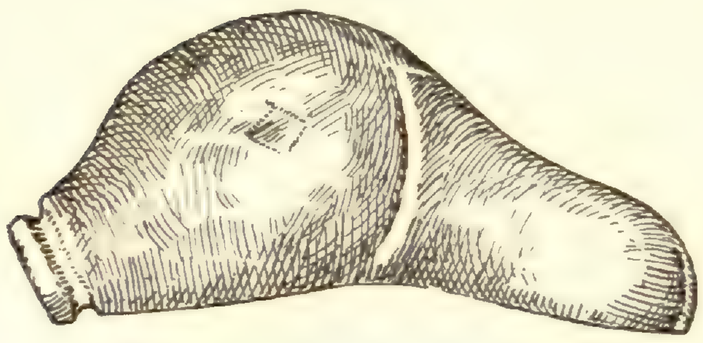


FIG. 15.—Pendant of lime-rock. Marco. (Full size.)

FIG. 16.—Pendant of lime-rock. Marco. (Full size.)

FIG. 17.—Pendant of lime-rock. Marco. (Full size.)

FIG. 18.—Object of clay. Marco. (Full size.)

On the other hand, it might be asked, if buildings were thus destroyed, why, in view of the preservative qualities of the muck, the debris was not preserved with the objects which were present. On the whole, the question is an interesting one.

A careful search of the surface of the shell fields of Marco resulted in the discovery of a number of tools wrought from entire shells, some of which differ somewhat from those described and figured in our former report on this region. Varieties, hitherto undescribed, from Marco; from Goodland Point, Key Marco; from Chokoloskee Key and from other localities, will be given at the close of this report.

[1] *Op. cit.*

We obtained from Mr. Collier a collection of several hundred pendants or "charm-stones," of shell, of coral, and of the coarse lime-rock found upon the keys. Most of these were of ordinary type, similar to a number figured by us in our preceding report.

FIG. 19.—Pendant of shell. Nameless Key near Key Marco. (About full size.)

One pendant from this lot of surface-finds from Marco, of rather compact, yellow lime-rock, representing the head of a duck, is shown in Fig. 15. Two pendants, one of yellow, one of white, lime-rock, also from Marco, are shown in Figs. 16, 17. A pyramidal object of tenacious clay containing quartz grains and fragments of shell, molded and dried, from the same collection, is given in Fig. 18.

From a nameless shell key, near Marco, a large number of objects, similar in the main to those from Marco, were obtained from Mr. Addison, who lives on the key. One of these specimens is a pendant of shell, which in addition to the groove at one end for suspension, has another groove around the body, the use of which is uncertain (Fig. 19). An implement of bone, from the surface, with four perforations, is shown in Fig. 20.

FIG. 20.—Implement of bone. Nameless Key near Key Marco. (About full size.)

A number of implements wrought from entire shells were found by us on the surface of this key.

FIG. 21.—Pendant of earthenware. Goodland Point. (About full size.)

GOODLAND POINT, KEY MARCO.

From Goodland point, five miles below the town of Marco, where many objects of interest were procured on our previous visit, we obtained a limited number of pendants, sinkers, etc., of stone, of shell, of coral, and one (Fig. 21) made from a fragment of an earthenware vessel. Many implements wrought from entire shells, were gathered by us from the surface at this point.

WIGGINS KEY, LEE COUNTY.

The only object of interest obtained by us on Wiggins key is a pendant of shell, having a perforation in addition to the groove at one end (Fig. 22).

FIG. 22.—Pendant of shell. Wiggins Key. (About full size.)

CHOKOLOSKEE KEY, LEE COUNTY.

The interesting Chokoloskee key, described in our previous report, has been determined, by a recent survey, to be in Lee county, and not in Monroe county, as was formerly believed to be the case.

A search, extending over a number of days, yielded many fine implements wrought from entire shells; also a number of pendants, etc., were obtained from persons inhabiting the key. Among these was a carefully wrought pendant of lime-rock (Fig. 23), presented to us by

FIG. 23.—Pendant of lime-rock. Chokoloskee Key. (About full size.)

FIG. 24.—Pendant of shell. Chokoloskee Key. (About full size.)

FIG. 25.—Pendant of shell. Chokoloskee Key. (Full size.)

Doctor Green, postmaster of Chokoloskee, and two pendants of shell, one heart-shaped (Fig. 24), the other showing a method of suspension entirely novel in our experience of objects of shell (Fig. 25) and unusual in pendants of stone, consisting of a perforation, beginning near the end at one side, and coming out at the top. Another fine pendant of shell from this place is shown in Fig. 26.

A novel object from this key is an oyster-shell having a central perforation and, in addition, a groove at one end, as shown in Fig. 27. Presumably a handle, passing through the hole, was lashed to the shell at the groove to form a tool. A part of the shell, broken from the edge back, lends support to this supposition.

FIG. 26.—Pendant of shell. Chokoloskee Key. (Full size.)

At our former visit to Chokoloskee key we made the acquaintance of Mr. C. G. McKinney, then living there. Mr. McKinney had for a long period paid close attention to aboriginal objects found upon the key. We were informed by him that, of the very many objects known as "sinkers" found on the key, none had been met with near the water, and that he was firmly convinced that these so-called "sinkers" had a use other than one pertaining to the taking of fish.

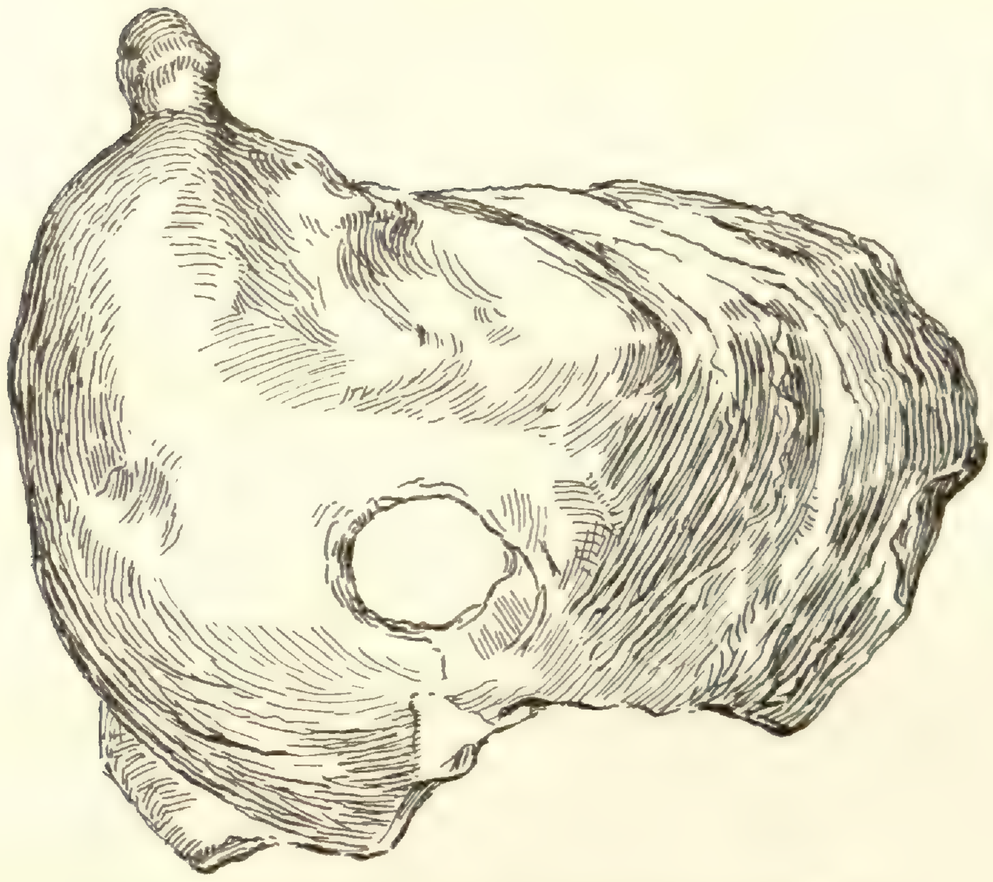


FIG. 27.—Implement of shell. Chokoloskee Key. (Full size.)

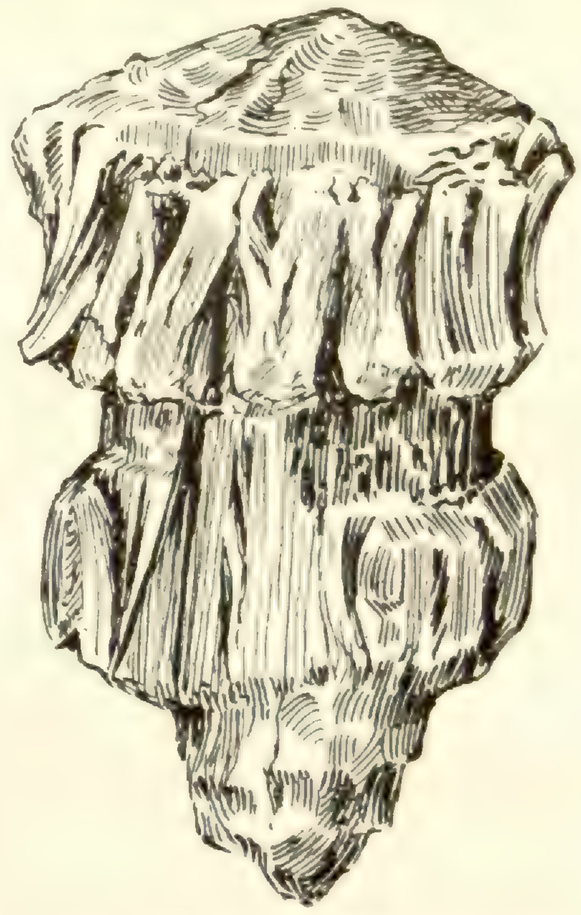


FIG. 28.—Object of black mangrove wood. Chokoloskee Key. (Half size.)

FIG. 30.—Cup of wood. Chokoloskee Key. (Full size.)

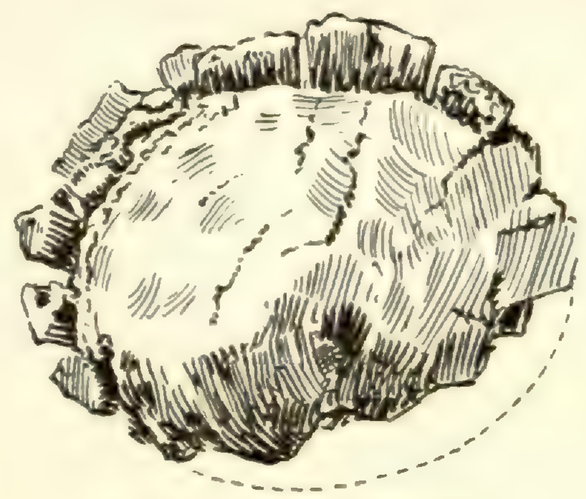


FIG. 29.—The same, end view.

In one part of the key is an interesting artificial harbor, which, no doubt, served as a shelter for canoes in aboriginal times. This harbor, protected from open water by an embankment of shell, save at a narrow entrance, was on property owned by Mr. McKinney, who, controlling the water by the insertion of a sluice, dug many trenches in the muck with the idea to pile this material above water level, and thus to gain a rich area for cultivation.

In the course of this work, Mr. McKinney, whose archæological interest was ever alert, came upon three objects of wood, which are now in possession of the Academy.

One of these, of black mangrove, shown in Figs. 28, 29, was burnt somewhat

on one side by a person to whom it was entrusted by Mr. McKinney. This object, which was about 2 feet down in the muck, became cracked superficially in drying, in a way that might seem to represent carving in the figure. It has a central groove surrounding it and shows work of a blunt tool over both terminal surfaces. In shape the object resembles the head of a mace, for which the heavy mangrove wood would be especially fitted; but in the case of a mace there would be no cause to remove the handle. Possibly the object was used as a sort of hammer, with one end blunt, the other pointed, and was fastened at a right angle to a handle by means of the central groove.

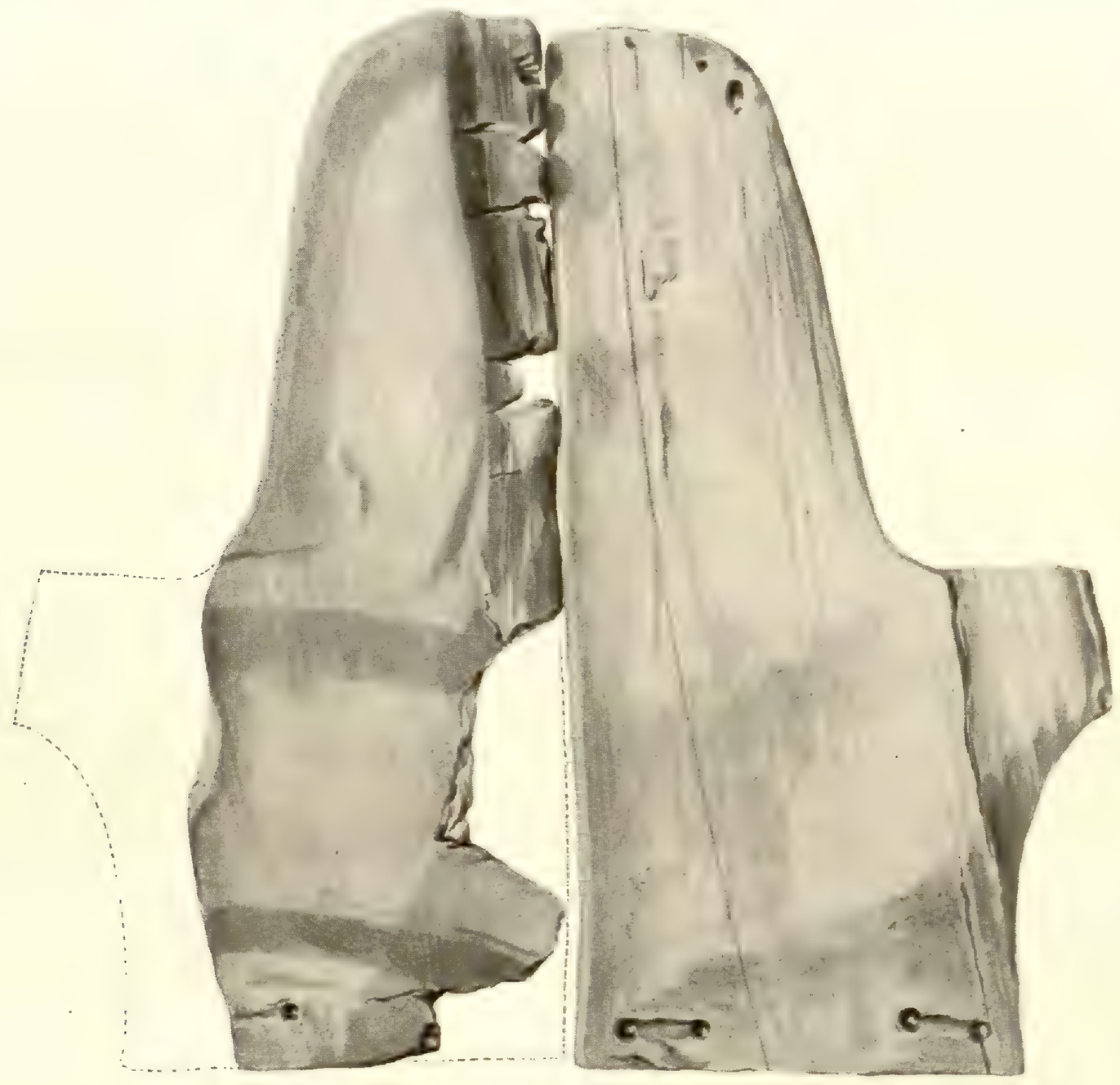


FIG. 31.—Object of wood. Chokoloskee Key. (Half size.)

A cup of a soft wood was found in the muck by Mr. McKinney (Fig. 30).

Another object, in two parts, also of a soft wood, is shown photographed from a sketch in Fig. 31. There has been a rude decoration in black pigment, still discernible in places. Holes for attachment are at the base. The purpose for which this object was made is problematical.

LOSSMAN'S KEY, MONROE COUNTY.

After investigating a number of keys which yielded nothing of interest from an archæological point of view, Lossman's key, one of the largest, if not the largest key of the Ten Thousand islands, was visited. At the northern extremity are large, level causeways and platforms, of shell, a thorough survey of which would be of interest.

South of Cape Sable and eastward among the keys and northward to Lake Worth, where our journey ended, we met with nothing of especial archæological interest. After leaving the Ten Thousand islands, no shell keys were met with by us during an extended search, all islands being of sand or of lime-rock.

IMPLEMENTS WROUGHT FROM ENTIRE SHELLS.

We shall now describe in detail certain implements of shell found by us during the expedition of 1904, which differ somewhat from implements of the same type described in our report on "Certain Antiquities of the Florida West-Coast."

FIG. 32.—Shell implement. Russell's Key. (About full size.)

FIG. 33.—Shell implement. Marco. (About full size.)

Fig. 32 represents a fractional part of a massive *Fulgur perversum*, of a type similar to that shown in Fig. 37 of our previous report, where a hole to the right, and a notch to the left, of the axis, enabled a handle to pass behind it. In this case, however, an additional perforation, much worn, behind the axis, is present, and probably corresponded with a hole since broken away through use. When this happened, presumably, the use of the hole back of the axis was abandoned, and a new hole to the right and a notch to the left were added. This implement, which was found on Russell's key, Ten Thousand islands, probably served as a hoe.

Fig. 34.—Shell implement. Cutler. (About full size.)

In Fig. 33 is given a *Fulgur perversum* from Marco, showing the usual removal of part of the body-whorl back from the edge of the aperture. There is a small hole above the shoulder, or periphery, which seems, as a rule, to have had no connection with the tool, inasmuch as numbers of shells, not made into implements, show a similar perforation, which may have been made to sever the muscle and free the shell-fish from its shell. The feature of this particular implement is two small, circular holes, side by side, in the back of the shell, facing the notch in

front. Possibly as one hole may not have given the desired angle for the handle, another hole was added.

Fig. 34 illustrates a *Fulgur perversum* from Cutler, on the mainland of the eastern coast, Dade county. It shows the usual removal of part of the body-whorl at the edge of the aperture, but no perforation above the shoulder. There are three perforations almost in line in the body-whorl, and a notch at the edge of the aperture. It would seem that the central hole which faces the notch, having become broken, was abandoned with its corresponding notch, and that two new holes were made for attaching the handle.

FIG. 35.—Shell implement. Battey Place. (About full size.)

The implement shown in Fig. 35, wrought from a comparatively small but heavy shell of the same species as the last, is of an ordinary type of which, in addition to the removal of part of the body-whorl, at the edge of the aperture, another part is cut away within, laying bare part of the axis. A single perforation in the body-whorl faces the notch. The peculiarity of this implement is the presence of two small perforations above the shoulder, in line, one on each side. These perforations are smaller and more regularly made than the single ones of which we

have spoken as made, possibly, to free the shell-fish from the shell. Moreover, there are two holes instead of one. One, above the main hole in the body-whorl, could have aided in attaching the handle, but the other hole is shut off from the handle by the convolution of the shell. This implement is from the Battey place, Pine island, Lee county.

FIG. 36.—Shell implement. Chokoloskee Key. (About full size.)

We come next to a *Fulgur perversum* from Chokoloskee key, shown in Fig. 36, which has the usual removal of part of the body-whorl. There is but one perforation, which is to the right of the aperture. This hole, which shows no wear, cannot have been used for the insertion of a handle, as there is no corresponding hole

on the opposite side, and no notch. Moreover, the hole is not in line with the required position for a notch. The cutting edge of the beak, however, shows considerable wear. Presumably, this implement was held directly in the hand.

The implement shown in Fig. 37, a heavy *Fulgur perversum*, with part of the body-whorl removed, and a small, irregular hole above the shoulder has four perforations in line in the remaining part of the body-whorl, extending from the aperture around from left to right. The first and third holes are in line for a handle, as are the second and fourth. The third hole corresponds also with a notch in the edge of the aperture. This implement, which has a fine edge, probably served as a gouge. Like the preceding example, it came from Chokoloskee key.

FIG. 37.—Shell implement. Chokoloskee Key. (About full size.)

In the collection is an implement from Goodland Point, Key Marco, in every

way similar to the foregoing save that the notch is absent. It lay on the surface, as was the case with all the implements described in this collection.

A badly battered *Fulgur perversum*, which probably served as a hoe, came from Chokoloskee key (Fig. 38). The body-whorl has been cut away a number of inches back. The rude hole above the shoulder is present. There are three holes in line somewhat below the shoulder, and a notch. The first and third holes, counting from left to right, allowed a handle to pass to the right of, and behind, the axis, but as parts of the shell gave way at the third hole, this hole

FIG. 38.—Shell implement. Chokoloskee Key. (About full size.)

FIG. 39.—Shell implement. Chokoloskee Key. (About full size.)

FIG. 40.—Shell implement. Chokoloskee Key. (About full size.)

became useless, and, consequently, the corresponding hole became unserviceable. The tool was then utilized by making hole number two and a corresponding notch.

There is represented in Fig. 39 a *Fulgur perversum* with cleanly-ground edge at the beak, having the customary rough perforation above the shoulder, or periphery. The body-whorl is in part removed. There are two evenly-made perforations to allow a handle to pass to the right of, and behind, the columella, but there is also a notch which does not correspond with either hole. This implement came from Chokoloskee key.

FIG. 41.—Shell implement. Fikahatchee Key. (About full size.)

FIG. 42.—Shell implement. Goodland Point.
(About full size.)

FIG. 43.—Shell implement. Goodland Point.
(About full size.)

Fig. 40 shows a *Fulgur perversum*, from the same key, with the hole above the shoulder and the body-whorl removed in part from the edge, backward. Also, as is often seen in these tools of shell, a part of the body-whorl has been cut away, exposing the upper third of the columella. There are three perforations, almost in line, somewhat below the shoulder. Numbers one and three from left to right would allow a handle to pass behind and to the right of the columella; hole number two probably corresponded with a notch on the edge which has been broken away.

Fig. 41 illustrates a *Fulgur perversum* from Fikahatchee (sometimes spelled Fakahatchee) key,[1] Ten Thousand islands. The perforation above the shoulder is present; the body-whorl has been removed several inches from the edge, backward. The beak is ground to give an excellent cutting edge for a gouge. There are two holes through which a handle could pass to the right of the axis and behind it; and there is a circular hole in the body-whorl to the right of the aperture, the use of which is not plain. This latter hole corresponds with neither of the other two holes and is entirely out of line for a notch, which, moreover, is not present. It is possible that this implement belongs to the type, where part of the body-whorl, above, has been removed, perhaps to facilitate attachment of the handle; but if so, the hole is much more evenly-made and rounder than is usually the case in openings of this kind.

Fig. 42 shows a type of implement found in abundance among the Ten Thousand islands, consisting of *Fasciolaria*, with much of the body-whorl removed and two perforations behind, to allow a handle to pass at an upward angle, behind the columella. A round hole is present in the body-whorl in front, evidently to aid in attachment. This specimen, which was used as a hammer, came from Goodland Point, Key Marco.

Fig. 43 represents an implement from Goodland Point, which, though shown in a different position, is similar to the one last described, save that it has a beautifully-ground, cutting edge for use as a chisel. This specimen is the sole example of this type that we have met during our two expeditions through the Ten Thousands islands.

Incidentally, it may be said that, as can be seen by referring to our "Certain Antiquities of the Florida West-Coast," page 393, the *Fulgur carica*, or *Fulgur* with the aperture to the right, is not found on the western coast of Florida, and hence the aborigines of that region were restricted to *Fulgur perversum* and *Fasciolaria* for use as implements.

On the eastern coast of Florida *Fasciolaria gigantea* is infrequently met with, and *Fulgur perversum* is far less massive than is that shell on the western coast of Florida. Therefore, on the eastern coast the aborigines were almost restricted to *Fulgur carica* in the manufacture of implements destined for heavy work.

All over Florida, however, *Fulgur perversum* was used for drinking cups, and "celts" made from the lip of the massive *Strombus gigas* are found.

[1] *Op. cit.*, p. 377.

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MOUNDS NEAR MOUNDVILLE, ALA.

Scale in feet

0 50 100 500

1905

Moundville Revisited

Crystal River Revisited

Mounds of the Lower Chattahoochee and Lower Flint Rivers

Notes on the Ten Thousand Islands, Florida

BY

CLARENCE B. MOORE.

PHILADELPHIA
1907.

MOUNDVILLE REVISITED.

By Clarence B. Moore.

In the season of 1905 we conducted an investigation in the mounds and cemeteries near Moundville,[1] Ala., which place, near the Black Warrior river, is but a few miles distant from the city of Tuscaloosa. Later, we published an account[2] of our work at Moundville.

At the time of this investigation a comparatively small, but seemingly desirable, part of the plateau was not dug into by us on account of the advanced state of the cotton which had been planted upon it. To explore this portion, and to do additional work in other parts investigated by us before, we returned to Moundville in November, 1906, with the cordial approval of Messrs. Hardy Clements of Tuscaloosa, and C. S. Prince of Moundville, owners of the mounds and cemeteries near Moundville, with whose consent our previous work had been done.

As what we considered a thorough investigation of the mounds had been made at our first visit, we devoted but little time to them on our return—digging into none of them with the exception of Mound Q. This mound had been well covered with trial-holes without result. But as it had on its summit plateau dark, rich soil to a considerable depth, and as in soil of this kind burials usually are present and because, in the material thrown out from a trial-hole, one of our diggers had found a small ornament of sheet-copper, we decided to give the mound another trial.

On our second visit, the summit plateau of Mound Q was fairly riddled by us with trial-holes. Our former judgment was confirmed.

A plan of the Moundville mounds, prepared by Dr. M. G. Miller, who has had charge of the anatomical part of all our investigations, accompanies this report, for the literary revision of which, and of the other papers in this volume, we are indebted to Mr. F. W. Hodge.

Somewhat less than one month was spent by us at Moundville on our second visit, with a force of from ten to sixteen men to dig. Every part of the great plateau in the neighborhood of the mounds, which seemed to offer any chance for results, was dug into by us. In many instances no burials were found; in others burials widely apart were encountered with which were no artifacts. In a few localities our work was rewarded.

[1] Formerly called Carthage and so spoken of in Pickett's "History of Alabama"; Thruston's "Antiquities of Tennessee"; *et al.*

[2] "Certain Aboriginal Remains of the Black Warrior River." Journal of the Academy of Natural Sciences of Philadelphia, Vol. XIII.

While, beyond question, objects of interest must yet lie buried at Moundville, it is our belief they are widely scattered—too widely so to warrant sustained investigation. At all events our work at this interesting place is, in all probability, ended.

At our former visit to Moundville, no urn-burials were met with. At our second investigation, however, two were encountered which, later, will be more fully described. One of these lay at a depth of about four feet among undisturbed burials of other kinds, and surely was contemporary with these prehistoric interments.

On our first visit, no human remains were recovered entire.

On our second visit, some bones in somewhat better condition were found, owing, perhaps, to the fact that most of our successful work was done in the ground south of Mound D, which is a narrow plateau having deep gullies on two sides, which possibly are conducive to better drainage. However, a number of bones, including one skull, came from localities at Moundville other than the one we have named.

Two skulls were recovered intact. One of these is now in the collection of the Academy of Natural Sciences of Philadelphia (catalogue number 2233). The other skull is at the United States Army Medical Museum, Washington, D. C., and has been reported on by Dr. Aleš Hrdlička as follows:

"The skull which you wished me to examine, marked 'Field near Md. M., Burial No. 57, Moundville, Alabama,' and preserved in the Army Medical Museum, shows the following features:

"The cranium is that of a young female adult. It presents a slight and mainly postparietal, accidental (cradle-board), compression.

"The specimen shows plain Indian features. Its consistency and good state of preservation of some of the more delicate bones, suggest but a moderate antiquity. In type it approaches the form that was common to the tribes of the southeast and those of later arrival speaking the Creek language. It is impossible to compare it with the Alibamese or other old tribes in Alabama, on account of lack of material: there are in the National Museum collection but four skulls from the State, and all these show artificial, 'flat-head,' deformation, which obscures the cranial type.

"Detailed Description and Measurements:

"The specimen shows average Indian features in almost every particular. The capacity is 1380 c. c., which indicates in a female a fair sized brain. In shape it is mesocephalic (cephalic index 78) and high (basion-bregma height 14.3 cm.), but a slight shortening and augmentation in height is due to the occipital compression. The face presents a moderate alveolar prognathism, such as is usual among the Indians. The various ridges and processes indicate moderate muscular development. The sutures are all quite simple, and contain but three small Wormian ossicles (all in the lambdoid); those of the vault show no trace of occlusion. The base exhibits rather small middle lacerated foramina, but a slight depression of the

petrous parts and rudimentary styloids—all characteristic Indian features. The nasal aperture is mesorhinian (index 50.), the mean index of the two orbits is mesoseme (87.), neither of which is exceptional. The teeth are of moderate size and normal form, but both of the third molars are congenitally absent.

"Measurements:

"Diameter antero-posterior max.	17.5 cm.
"Diameter lateral max.	13.65 "
"Facial height (alvion-nasion)	6.95 "
"Facial breadth (d. bizygomatic max.)	13.25 "
"Upper Facial Index 52.5	

"Height of nose, 4.8; breadth max., 2.4 cm.;
"Height of right orbit, 3.2; of left, 3.3 cm.;
"Breadth of right orbit, 3.8; of left, 3.7 cm.;
"Maximum circumference of skull above supraorbital ridges, 49.2 cm.;
"Nasion-opisthion arc 35.3 cm.;
"Thickness of left parietal 4–6 mm.

"I trust the above report will prove of some utility. It should be kept in mind that, except under very special circumstances, an examination of a single skull is of little significance and not fit to base any important conclusions upon."

On our first visit a fragment of a skull showed moderate artificial flattening. Many other smaller fragments gave no evidence of this treatment.

A small number of fragmentary skulls, found at the time of our second visit, showed the effect of moderate cranial compression; while a far larger number of fragments evidently belonged to normal skulls.

During our first investigation, fragments of human remains were found presumably bearing traces of the effects of a specific disease.[1] At our second visit many bones were found, sometimes a number belonging to one skeleton, showing such decided lesions that all these remains were carefully put aside and, later, were given by us to the United States Army Medical Museum.[2] The result of investigation at that institution has kindly been reported to us as follows:

"Dr. James Carroll, First Lieut. and Asst. Surgeon, U. S. Army, Curator Army Medical Museum,

"Sir:—

"In accordance with your instructions I have the honor to report that the lot of bones from mounds at Moundville, Ala., contributed by Mr. Clarence B. Moore, comprised about 70 pieces, some of them rather fragmentary. Of these 70,

[1] William C. Mills, M.Sc., found a large number of syphilitic bones in the Baum prehistoric village site, Ohio. "Explorations of the Baum Prehistoric Village Site," Fifteenth Annual Publication Ohio State Archæological and Historical Society.

See also "*Der Ursprung der Syphilis* (*Morbus Americanus*)." *Internationaler Amerikanisten-Kongress*, Stuttgart, 1904. "*Der Ursprung der Syphilis*," Jena, 1901; both by Dr. Iwan Bloch.

[2] With these bones were sent certain reunited fractures and some normal bones belonging to skeletons showing abnormalities.

fifty show the usual conditions found in bone-syphilis, such as periosteal nodes, especially along the crest of the tibia, irregular erosions, scleroses and necroses of long bones, erosions of calvarium as from gummata; many bones of the same skeleton being affected. I do not think there can be any doubt that these bones are from cases of syphilis.

"Some other bones of the lot show exostoses of uncertain origin; the remainder are either normal or show fractures more or less healed.

"Very respectfully your obedient servant,

"D. S. Lamb, Pathologist."

Among hundreds of objects found by us during both our visits to Moundville, not one, either as to material or in method of treatment, gave any indication of other than purely aboriginal provenance, and it is our belief, as well as that of eminent archæologists who have examined the artifacts from Moundville, that the occupancy of the site was prehistoric.

The art of Moundville is homogeneous. The same classes of objects were found there with human remains whose only trace was a black line in the soil, as were encountered with better-preserved skeletons. Not only, as we have said, did we fail to find at Moundville a single object denoting European contact, but there is no report of any such having been met with there throughout years of cultivation. It is well known to mound-investigators what importance is attached by inhabitants of a place to the discovery of any object of intrinsic value, be that value ever so small. The finding of a bead of gold or of a cross of silver causes more talk than would a whole collection of aboriginal objects of stone. At Moundville, among whites or blacks, no rumor as to precious metals is current, though on all sides one hears reports of the discovery of pipes of stone, of objects of shell and the like—reports which in justice to the tactful and intelligent people of Moundville we must say almost invariably proved correct.

HUMAN REMAINS.

Near Mound A.

At the time of our former visit, some work was done in the level ground near the western side of Mound A, resulting in the finding of a number of skeletons not associated with artifacts of any sort.

This time, there being no interference on account of growing crops, as was the case before, we devoted eight hours to the locality, with an average of fifteen men, making trenches and trial-holes. Ten burials were encountered, consisting of eight skeletons at full length upon the back; an aboriginal disturbance; and a single skull. The burials, which were from one to three and one-half feet in depth, had no accompanying artifacts, with the exception of one skeleton with which were a bowl and a water-bottle.

Ground Northeast of Mound C.

The ground lying to the northeast of Mound C was considerably dug into by us at the time of our first visit.

On our second visit much additional digging resulted in the discovery of seven skeletons of adults, lying at full length on the back; one lying on the left side, partly flexed; one aboriginal disturbance; one skeleton of an infant or of a very young child; one of an adult, at full length on the back, the upper and lower parts being separated by a space of two feet.

A few comparatively uninteresting vessels were found with the remains.

Ground South of Mound D.

We investigated to a certain extent at the time of our first visit the narrow strip of land between two deep gullies south of Mound D, which is shown in the plan of the mounds.

This time, in addition to numerous trial-holes all over the ground to the north, as well as to the south of Mound D, a part of the area, 172 feet long, with a maximum width of 46 feet (see plan, Fig. 1), was dug through by us to undisturbed ground below. This work required from ten to sixteen men to dig, with three men to oversee, for more than ten days of eight working hours each, a certain part of this time, however, being occupied in refilling.

Fig. 1.—Plan of ground near Mound D, showing excavation.

The ground, dark with organic matter, evidently an accumulation during long occupancy, had an average depth of about 2.5 feet, when undisturbed yellow clay was reached. Into this clay grave-pits had been dug in places. In other instances burials had been made in the accumulated soil above the clay. The limits of the graves in the soil above, and in some instances of those in the clay, were not determinable owing to the constant digging and redigging for burial that had gone on in ancient times, grave cutting through grave, rendering impossible exact delimitations, and at the same time creating sad havoc to skeletons and to pottery. In our enumeration of burials we shall call such as suffered in this way aboriginal disturbances, where considerable parts of the skeleton remained, but shall take no note of single bones scattered here and there, of which there was a great abundance.

During our digging south of Mound D, 174 burials were encountered by us, as follows:

Adults full length on the back,	79
Adolescents full length on the back,	12

Adults lying on the right side, the limbs partly flexed,	4
Adults lying on the left side, the limbs partly flexed,	4
Adult closely flexed on the back, the knees drawn to the chest,	1
Adult extended to the knees from which the legs flexed downward,	1
Children and infants,	19
Child in sitting position with knees turned to left at an angle of forty-five degrees,	1
Urn-burials of infants,	2
Aboriginal disturbances,	47
Disturbed by our diggers,	2
Not determined on account of decay,	1
Not determined,	1

This last skeleton lay in soil so hard that it was impossible to uncover it except piece-meal.

Burials numbers 40 and 41, an adult and infant (Fig. 2), both fully extended on their backs, lay in a grave together. The grave, the base of which was 4.5 feet from the surface (an exceptionally great depth for an aboriginal interment at Moundville), extended about 1.5 feet into the hard clay, above which was the dark earth made by aboriginal occupancy, 3 feet in depth at this point.

That part of the grave which was in the clay was sharply defined and was filled with yellow sand. No sand was encountered by us elsewhere in our work on this strip of ground, though similar sand is found in a neighboring field.

It was impossible, owing to the number of aboriginal disturbances, to determine from what level the grave was begun —whether from the original level, that is to say the surface of the clay, or from some stage in the period of formation of the artificial soil, or from the present level of the ground.

That part of the grave which lay in the hard clay was, as we have said, sharply defined, the sides being clearly cut and perpendicular. The length was 7 feet 4 inches; the breadth varied from 1 foot 4 inches to 2 feet.

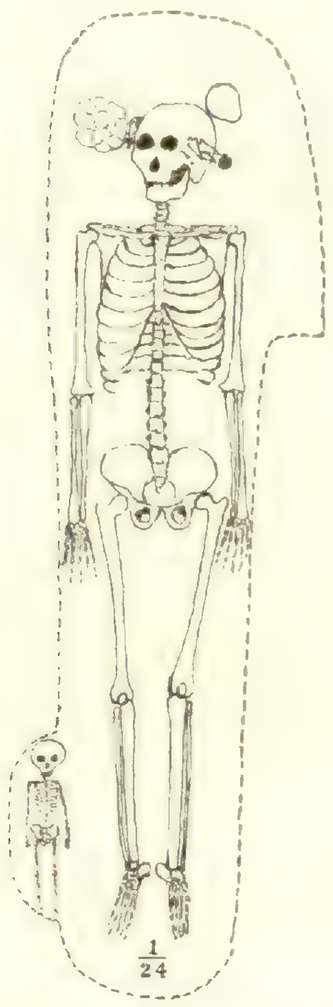


FIG. 2.—Burials numbers 40 and 41. Ground south of Mound D.

On the lower right-hand side was an offset in which the infant's skeleton lay. Another offset was on the opposite side, but at the other end of the grave. Nothing was found in this offset, though presumably it was made for a purpose and perhaps originally contained objects of a perishable nature.

By the side of the skull of the adult skeleton, which lay almost due east and west, the head being directed toward the east, were a broken water-bottle and a cup-shaped vessel. In the sand near the left-hand side of the skull was an ear-plug of wood, copper-coated, badly decayed. In contact with each temporal bone were several pendants and parts of pendants of sheet-copper.

In another part of the ground, four feet down, 1 foot 3 inches of which were in solid clay, was an inverted bowl 13.5 inches in diameter. This bowl, a part of which was crushed, covered from the head to the waist the skeleton of a small infant. The leg bones, which were missing, probably had extended beyond the bowl and had been cut away without discovery by our digger. With the skeleton were small shell beads, and below it was a large mussel shell (*Quadrula boykiniana*[1]), the concave side uppermost, which may have contained some perishable offering.

About 6 inches below the surface was a bowl 14 inches in diameter and about 6 inches deep, resting on its base. Within were a few decaying fragments of bone, apparently having belonged to the skeleton of a very young infant.

Above this bowl was another bowl, or a large part of another one, badly crushed.

The presence of urn-burials at Moundville was not a surprise to us, inasmuch as this form of burial was practised along the Alabama and Tombigbee rivers, though it is remarkable that but two instances were encountered by us in all our digging at Moundville.

Field East of Mound G.

In the field east of Mound G twenty-nine trial-holes were sunk, and two burials without associated artifacts were encountered.

Field near Mound M.

Not shown on our plan of the mounds is a great field outside the circle, which was not investigated at the time of our first visit as the cotton growing upon it was then too far advanced to be disturbed. In this field, 325 feet WSW. from Mound M, is the remnant of a conical mound of clay.

Our work at this place, in addition to many trial-holes in all directions, was continued for two days with a force of twelve men, beginning 65 feet in a northerly direction from the base of the remnant of the mound to which reference has been made.

Fifty-nine burials were encountered, none differing in form from those described as coming from the ground south of Mound D.

At this place some burials seem to have been made in the underlying clay, while others were in pits evidently put down from the surface. With the deeper burials no artifacts were found, and but few—all purely aboriginal—were with the other burials.

At this place, as elsewhere, a number of bones showing a specific disease were present. No determination could be reached as to the condition of the deeper bones owing to their advanced stage of decay.

[1] All determinations of shells in this and accompanying papers have been made by Dr. H. A. Pilsbry and Mr. E. G. Vanatta, of the Academy of Natural Sciences of Philadelphia.

Field West of Mound N.

The digging in the field west of Mound N consisted of twenty-seven trial-holes put down in the immediate neighborhood of the mound.

Eight burials were encountered, of which but one had associated objects.

Ground near Northern Side of Mound Q.

Some digging was done by us at our former visit, in the level ground near the northern side of Mound Q, resulting in the finding of skeletons without artifacts in association.

Additional work on our second visit yielded four skeletons, all lying at full length on the back, having no associated objects.

Field West of Mound R.

This tract, connected with the great field which is surrounded by the mounds, lies outside the circle, to the westward of Mound R. It was investigated by us to some extent at the time of our first visit.

On our second visit, two and one-half days were spent putting down trial-holes and trenching in this place, with an average force of ten men.

As the fifty-eight burials we found here differed in no material respect from the interments encountered in the ground south of Mound D, they will not be particularly described although exact details of their occurrence, as indeed of all we found at Moundville, are included in our field notes.

The association of two of the burials was striking. Burial No. 25, the skeleton of an adult, lying on the left side with the legs somewhat drawn up, had, resting on the left arm, the skeleton of an infant.

At this place were graves in the red clayey sand underlying the clay of the field, which was discolored with organic matter. Some of these graves were 5 feet below the present surface, and did not seem to be connected with it. Other and shallower graves, filled with material extending down from the surface, also were present.

In the deeper graves no artifacts save shell beads were present with the burials, all other objects found being in the shallower graves. All these objects, however, were purely aboriginal and of the same character as those found in other mounds and cemeteries of Moundville.

Several other places, after considerable digging, yielded single skeletons.

POTTERY.

The pottery of Moundville, as we have said in our former report, varies little in form, being confined mainly to the bottle, the pot, and the bowl. The engraved designs on the pottery are its main feature of interest.

As we found to be the case before, earthenware vessels, when present, as a

rule lay near the head of skeletons, though there were exceptions to this, some of them caused by disturbance of the graves in aboriginal times in making other interments.

Much of the ware (which is shell-tempered) is covered with a glossy, black coating, sometimes of great beauty. In our former report we said that this coating was not produced by the heat in firing the clay, and it is true that the direct action of heat upon clay would produce no such result. Presumably, however, the coating was obtained in the manner described by Holmes[1] as practised by the Catawba Indians, where the vessel, surrounded by bark, is covered by an inverted receptacle during the firing process. Bark burning in the confined space in which the vessel was would certainly yield considerable quantities of tar which first would condense on the sides of the vessel, and, being in a liquid state, would penetrate the porous material to some extent, subsequently being carbonized by further heating.

On our second visit to Moundville many vessels or large parts of vessels were found, some in many fragments. Such fragmentary vessels have been cemented together, and, where a part is missing, have been restored with a material somewhat differing in shade from the vessel, that our work and that of the maker of the ware may not be confused.

The number of vessels (many of which were badly crushed) found by us at our second visit, is as follows:

Near Mound A.	2
Ground northeast of Mound C.	5
Ground south of Mound D.	114
Field near Mound M.	9
Field west of Mound N.	2
Field west of Mound R.	28

In describing the Moundville pottery, we shall confine ourselves to the more noteworthy pieces, the commoner types having received sufficient attention in our former report.

In figuring pottery—and in fact all objects in this report—reduction in size is linear. Diagrams of the engraved decoration on the vessels are not absolutely exact as to size, owing to the difficulty of representing a curved design on a flat surface; otherwise they are essentially correct.

Dissociated in the soil were various effigies of heads, broken from earthenware vessels. These heads are mainly of birds, but they include also the head of a fish and one of an alligator.

There were also found in the digging many discs made from parts of earthenware vessels, three with central perforations.

One mushroom-shaped object of earthenware was unearthed, lying near the head of a flexed skeleton,—perhaps a modeling tool, as described by Thruston and Holmes.

[1] W. H. Holmes, "Aboriginal Pottery of Eastern United States," 20th An. Rep. Bur. Am. Ethn., p. 55.

Burial No. 39, the skeleton of an adult, lying on the left side and partly flexed, had, near the legs where perhaps it had been thrown by an aboriginal disturbance, an ear-plug of earthenware, shown in Fig. 3.

We shall now describe the more noteworthy vessels in detail, the ware being black in every instance, unless otherwise specified.

Vessel No. 2 from the field west of Mound R, is a bowl of coarse ware, of about one gallon capacity. Around a short neck, first upright and then slightly flaring, are eight loop-handles. The inside is decorated with bright red paint.

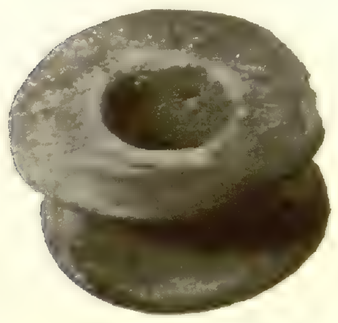


FIG. 3.—Ear-plug of earthenware. (Full size.)

Vessel No. 32 from the ground south of Mound D, is a small water-bottle having engraved upon it the well-known Moundville design of the open hand and eye.[1] In this instance the hand, which is shown five times, points downward as in the case of the next two vessels described.

Vessel No. 8 from the field west of Mound R, is a small bottle of fine, yellow ware, having the design of the hand and eye six times represented.

Vessel No. 27 from the ground south of Mound D, a cup, has this same design six times shown around the body of the vessel and once on the base.

Vessel No. 22 from the ground south of Mound D, a small pot of coarse, yellow ware, with two loop-handles and, on two opposite sides as decoration, a very rudimentary animal form.

Vessel No. 61 from the ground south of Mound D, is a small effigy-vessel representing a frog. Two larger vessels of this kind will later be particularly described and figured.

Vessel No. 5 from the ground south of Mound D, is a small bowl with a notched band around the rim and three equidistant, rudely modeled effigies of human heads, projecting upward. A fourth head is missing.

Vessel No. 76 from the ground south of Mound D, is a bowl, elliptical in outline (with part of the side missing), which has represented a fish. The tail is present, as are a notched ridge on one side for the spines, and projections on the other side for the ventral fins. The head is lacking through aboriginal breakage, and the projection left by it has been carefully smoothed and rounded by the aborigines.

Vessel No. 7 from the ground south of Mound D (Figs. 4, 5), presents a beautiful decoration which is four times shown. In the center of each design is a swastika within two concentric circles. Enclosing these are four series of three fingers each, representing the four directions. A band of cross-hatched design encircles the body of the vessel; with which band four equidistant, perpendicular bands, also cross-hatched, form the sign of the cross, or the four directions. Series

[1] For the symbol of the open eye on the open hand, in ancient Mexico see "*Altmexikanischer Schmuck und soziale und militärische Rangabzeichen,*" Prof. Dr. Eduard Seler. *Gesammelte Abhandlungen,* Fig. 99, pp. 569, 579.

FIG. 4.—Vessel No. 7. Ground south of Mound D. (Height 5.8 inches.)

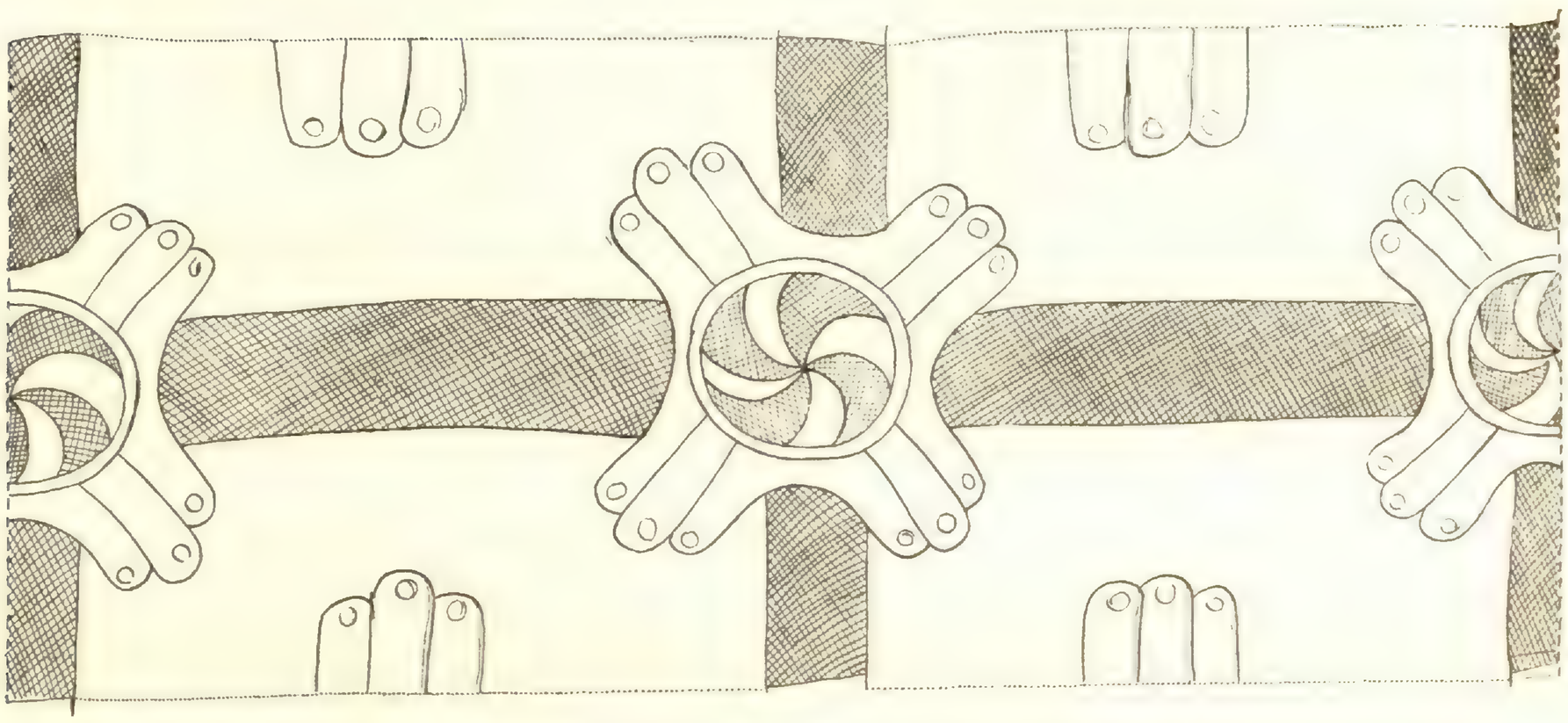


FIG. 5.—Vessel No. 7. Decoration showing swastika, cross of the four directions, and perhaps symbols for "above" and "below." (About two-thirds size.)

of three fingers point downward in the upper spaces enclosed between these bands, while similar series point upward in the lower spaces.

We know the ancient Mexicans[1] had six world-"quarters" which, in addition to the four cardinal points, included "above" and "below"; and that descendants of ancient Mexicans, the Huichol Indians,[2] have the six world-"quarters" also, as do certain tribes of Pueblo Indians of southwestern United States, including the Hopi[3] and Zuñi—as well as other Indian tribes.[4]

Doubtless the six world-"quarters" were recognized by the aboriginal occupants of the Moundville region, but whether they are represented on this vessel, the cross standing for the four directions (as it undoubtedly does), and the upturned fingers for "above" and the downturned ones for "below," is another question. It is likely the fingers in the spaces are simply a duplication in the design—a method often followed in the decoration of ancient pottery. Moreover, there are vessels from Moundville on which fingers are shown, which do not seem to carry out the idea of the six world-"quarters." A woodpecker design has downturned fingers in addition, but no upturned ones. Another vessel with a cross showing eight directions is without the upturned fingers, though the downturned ones are present.

On the other hand there is a vessel (all we are referring to now we found on our first visit) with the design of the double-headed woodpecker, the heads pointing in two directions, the tails in two other directions, thus making the cross of the four directions. In addition, series of fingers point upward and downward, thus indicating the six directions, although we may not accept the idea that it was the intention of the aborigines to do so.

In a word, it may be that either the aborigines at the beginning intended to represent the six directions in the way we have described, and later made use of parts of the symbol for decorative purposes, or, on the other hand, they never intended to represent "above" and "below" by upturned and downturned fingers, and that when these are shown, they were borrowed merely to fill space in the design, and were taken from the cross of the four directions, which often, at Moundville, was made up of four series of three fingers each, pointing in different ways.

The swastika was abundantly represented at Moundville; sometimes cut or *repoussé* in copper, sometimes engraved on earthenware; and doubtless the natives of the Moundville region often used this emblem embroidered on fabrics and painted on wood or on hide. Ranjel, DeSoto's secretary, tells how the great cacique of Tascaluça (Tuscaloosa), whose home was in the Moundville region, had before him always "an Indian of graceful mien holding a parasol on a handle,

[1] "*Codex Vaticanus* B." First half. Elucidated by Prof. Dr. Eduard Seler, pp. 67, 71, 242.
[2] Dr. Carl Lumholtz, "Symbolism of the Huichol Indians," Mem. Amer. Mus. Nat. Hist., Vol. III, p. 14.
[3] Dr. J. Walter Fewkes, "Hopi Shrines near the East Mesa, Arizona," Amer. Anthropologist, April–June, 1906, p. 357.
[4] "Handbook of American Indians," article "Color Symbolism."

something like a round and very large fly-fan, with a cross similar to that of the Knights of the Order of St. John of Rhodes, in the middle of a black field, and the cross was white."[1]

Though the accounts given by the chroniclers of the DeSoto expedition differ as to this banner, yet if we follow the description of Ranjel, an eyewitness, it is no hard task to recognize the swastika emblazoned on the standard of Tuscaloosa,[2] for although there is some difference in form between the swastika and the cross of the Knights of St. John, yet it is probable, as their cross was white on a black ground, like that of Tuscaloosa, that Ranjel gave more attention to this striking feature than to mere details of shape.

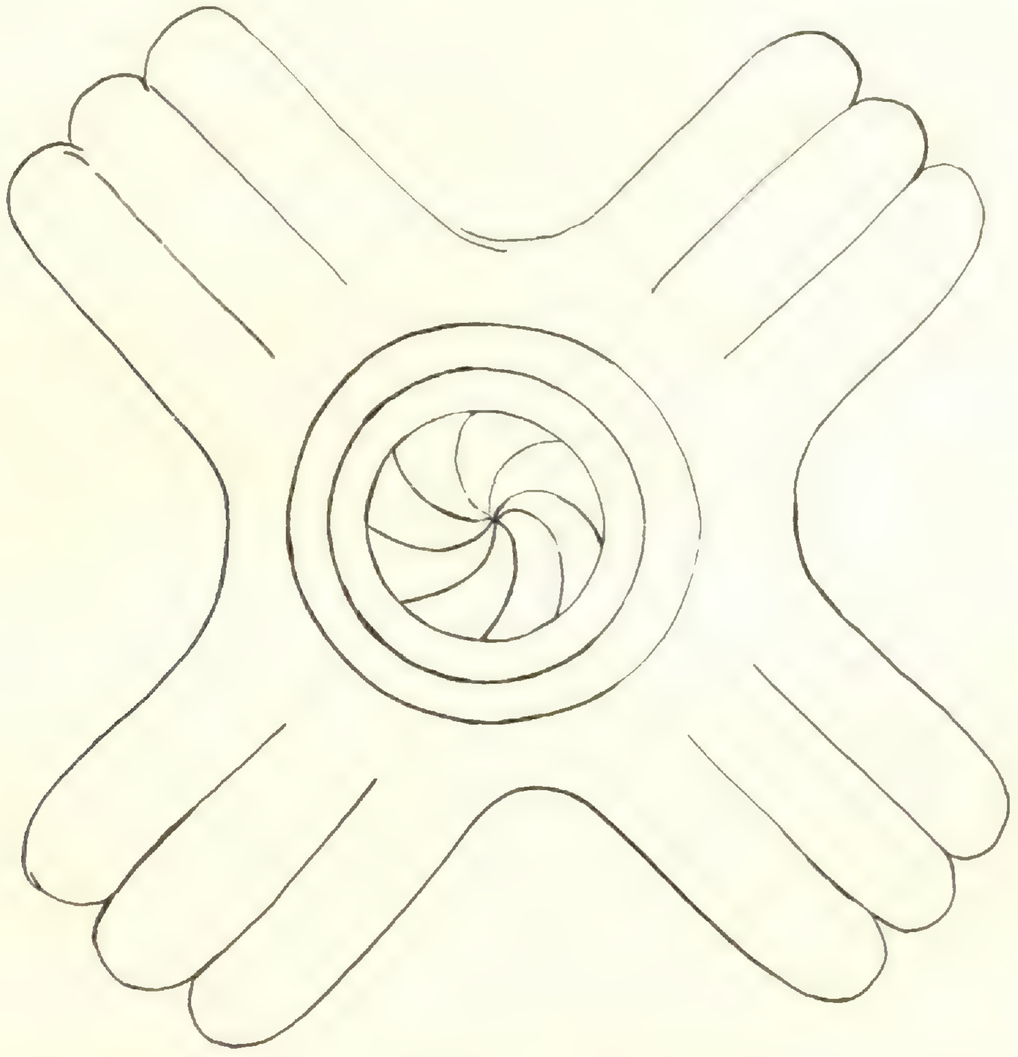


FIG. 6.—Vessel No. 28. Ground south of Mound D. Decoration showing swastika and also cross of the four directions. (About half size.)

Vessel No. 28 from the ground south of Mound D, is a cup having a rather faint decoration (Fig. 6) on the base, a swastika within three concentric circles; and

[1] "Narratives of DeSoto." Vol. II. "Relation of Ranjel," translated by Prof. Edward Gaylord Bourne, page 121. The paragraph is from Oviedo's "*Historia General y Natural de las Indias*," Vol. I, p. 567.

[2] The town, the province, and the cacique bore the same name. Theodore Irving, "Conquest of Florida," Vol. II, p. 34.

Tascaluça is correct Creek for "Black Warrior." T. H. Lewis, "Spanish Explorers," "Expedition of DeSoto," p. 186.

FIG. 7.—Vessel No. 54. Ground south of Mound D. (Height 4 inches.)

FIG. 8.—Vessel No. 54. Decoration showing cross with eagles' heads forming a swastika. (About half size.)

the cross of the four directions, the arms made up of series of three fingers each, extending up the sides of the vessel.

Vessel No. 54 from the ground south of Mound D, is a bottle (Figs. 7, 8) having a beautiful and unique decoration made up of a cross on the base, which, with the addition of eagles' heads on the sides of the vessel, forms a swastika.

Vessel No. 71 from the ground south of Mound D, a broad-mouthed water-bottle (as were so many of the vessels found at Moundville), has for decoration an

FIG. 9.—Vessel No. 71. Ground south of Mound D. (Height 6.7 inches.)

eagle's head and the open hand and eye, alternating each four times (Fig. 9). The pointed projections extending behind the eagle's eye are two in number in two opposite heads, and three in the other two.

Vessel No. 18 from the ground south of Mound D, is a bottle (Figs. 10, 11) having an engraved design showing the head, two wings, and tail of a bird, presumably—as fangs, teeth, and rattles are absent. The crest is unlike that of the woodpecker and, possibly, the head was designed to represent that of the eagle. It may be, however, the serpent-bird was intended.

Vessel No. 15 from the ground south of Mound D, a bottle (Fig. 12), has the design of the cross of the four quarters, four times represented.

Vessel No. 45 from the ground south of Mound D, a cylindrical vessel (Figs. 13, 14), bears a rather coarse, incised design twice represented, one being somewhat larger than the other.

FIG. 10.—Vessel No. 18. Ground south of Mound D. (Height 6.2 inches.)

Vessels No. 11 and No. 82 both from the ground south of Mound D, and vessel No. 2 from the field near Mound M (Figs. 15, 16, 17, 18, 19), all with meander

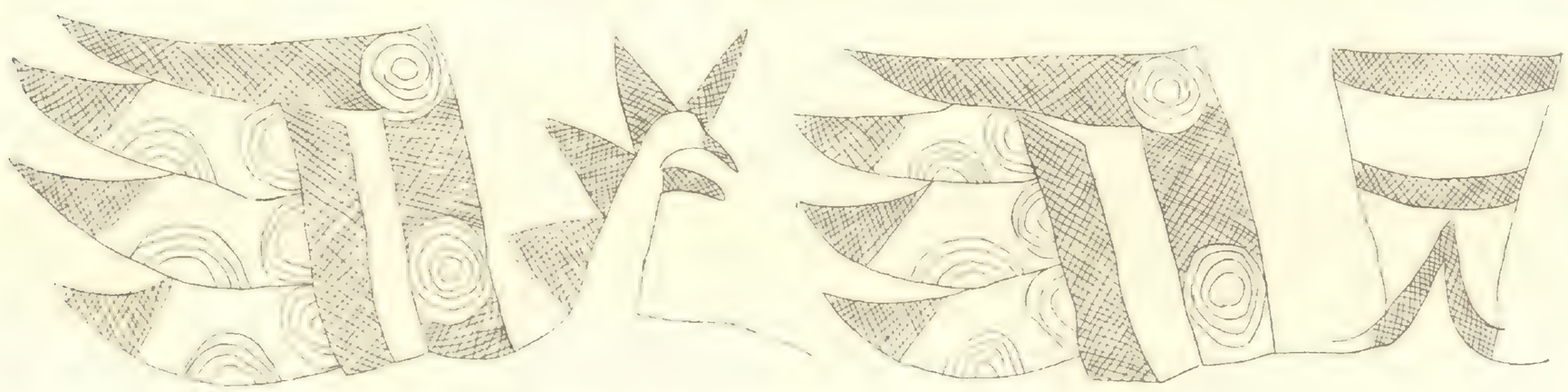


FIG. 11.—Vessel No. 18. Decoration. (About one-third size.)

decoration, are fair examples of the commoner designs present on Moundville pottery.

FIG. 12.—Vessel No. 15. Ground south of Mound D. (Height 3.75 inches.)

FIG. 13.—Vessel No. 45. Ground south of Mound D. (Height 4.6 inches.)

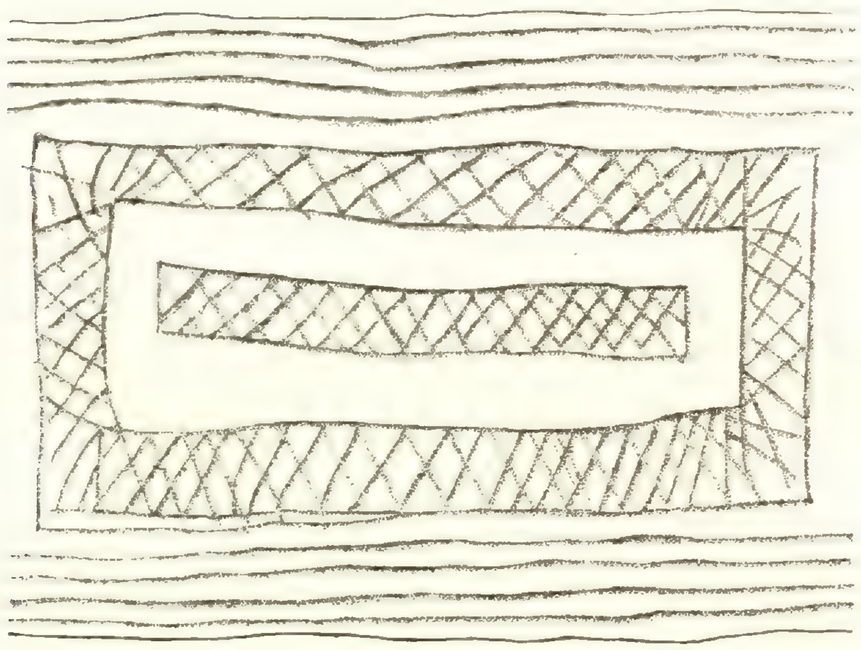


FIG. 14.—Vessel No. 45. Decoration. (About half size.)

FIG. 15. Vessel No. 11. Ground south of Mound D. (Diameter 5.3 inches.)

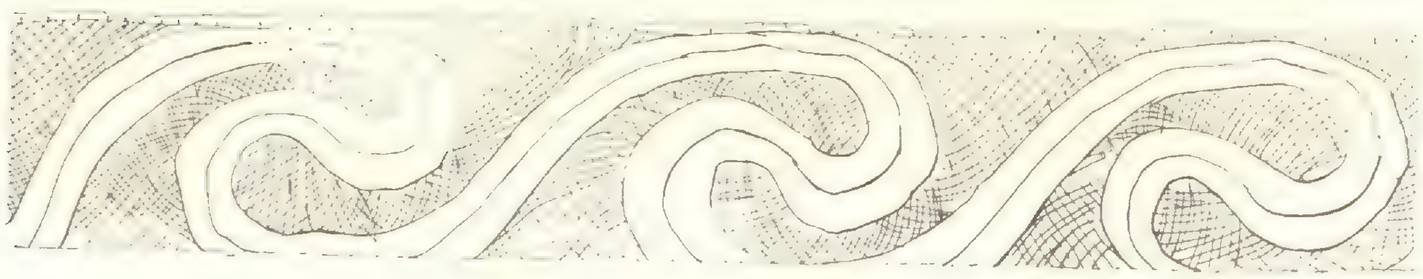


FIG. 16.—Vessel No. 11. Decoration. (About one-third size.)

FIG. 17.—Vessel No. 82. Ground south of Mound D. (Height 5 inches.)

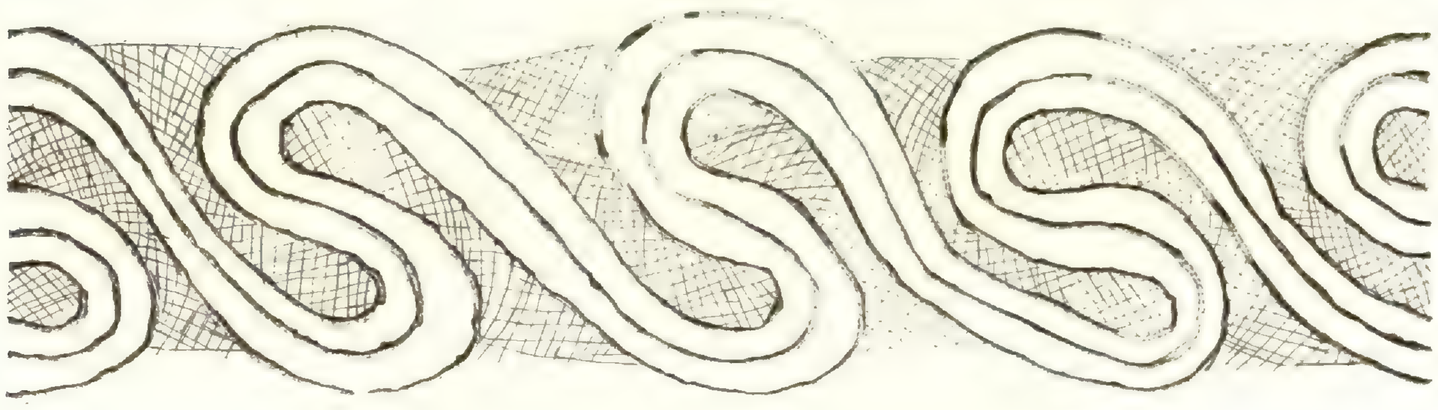


FIG. 18.—Vessel No. 82. Decoration. (About one-third size.)

FIG. 19.—Vessel No. 2. Field near Mound M. (Height 4.75 inches.)

Vessel No. 18 from the field west of Mound R, is a bottle (Fig. 20) with a painted design showing a skull or conventionalized head, and an open hand—each being present three times on the vessel. Painted decoration evidently was not in vogue at Moundville, as but three vessels so decorated have been found by us there. Holmes[1] describes and figures a bottle from Mississippi, with painted design almost

FIG. 20.—Vessel No. 18. Field west of Mound R. Painted design showing head or skull, and open hand. (Height 5.3 inches.)

exactly similar to ours, while Thruston[2] also shows one from Tennessee bearing the same general characteristics. The coloring on the Moundville specimen is light yellow on a ground of brown. The design, though plainly distinguishable, has become somewhat dimmed through lapse of time.

[1] "Aboriginal Pottery of Eastern United States," 20th An. Rep. Bur. Am. Ethn., Plate LVI, b and c, and page 106.

[2] Gates P. Thruston, "Antiquities of Tennessee," p. 136.

Vessel No. 20 from the ground south of Mound D, a bottle (Fig. 21), has a painted design, four times shown, originally red, no doubt, but now a dingy brown, which has the same shape as many of the sheet-copper pendants found at Moundville, which bear excised parts forming a swastika. In this instance, however, the excised triangle commonly seen on these pendants is absent.

An object of earthenware from the field near Mound M (Fig. 22) is included by us among pottery vessels, though we are unable to say what use it originally served.

FIG. 21.—Vessel No. 20. Ground south of Mound D. Painted design showing swastika. (Height 5.3 inches.)

FIG. 22.—Object of earthenware. Field near Mound M. (Height 6.2 inches.)

FIG. 23.—Vessel No. 106. Ground south of Mound D. (Height 2 6 inches.)

FIG. 24.—Vessel No. 103. Ground south of Mound D. (Height 5 inches.)

Vessel No. 106 from the ground south of Mound D (Fig. 23), has a curious marginal decoration of the "wall of Troy" pattern.

Vessel No. 103 from the ground south of Mound D (Figs. 24, 25), is a bottle bearing an incised decoration, the interpretation of which is entirely beyond our power. But as "no savage ever sat down to decorate an article from mere fancy with meaningless designs,"[1] this apparent confusion of line-work must stand for something, and may be interpreted some day.

FIG. 25.—Vessel No. 103. Decoration. (About half size.)

Vessel No. 110 from the ground south of Mound D (Fig. 26), a water-bottle of brown ware, of the fish-effigy variety, might have come from Tennessee instead of from Moundville, so far as any difference between it and Tennessee ware can be detected.

Vessel No. 15 from the field west of Mound R is a bowl (Fig. 27), representing a fish, spines are shown on the back, while projections below indicate the ventral fins.

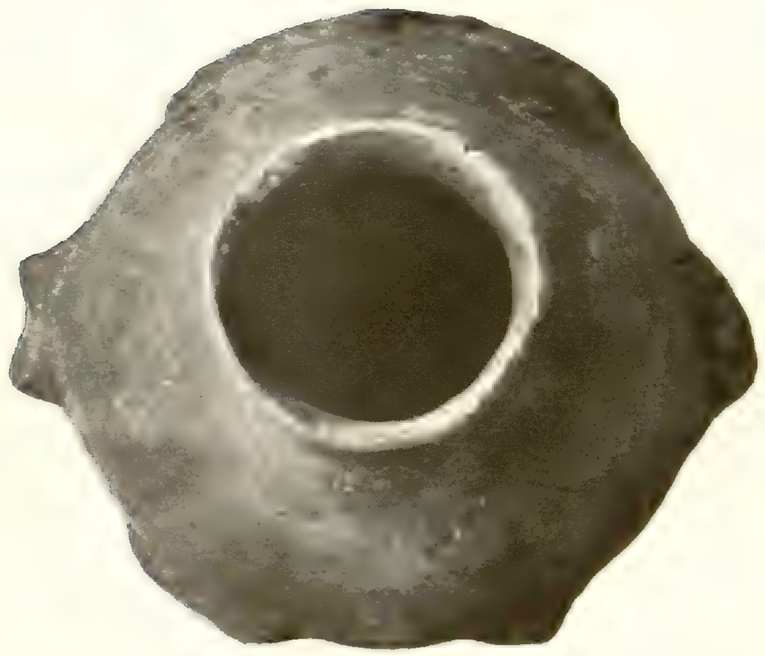


FIG. 26.—Vessel No. 110. Ground south of Mound D. (Maximum diameter 5.4 inches.)

FIG. 27.—Vessel No. 15. Field west of Mound R. (Maximum diameter 12.5 inches.)

[1] Lumholtz.

FIG. 28.—Vessel No. 55. Ground south of Mound D. (Height 4.9 inches.)

Vessel No. 55 from the ground south of Mound D, a small effigy-bottle (Fig. 28), strongly calls to mind the ware of Tennessée and of Missouri.

Vessel No. 1 from the field west of Mound M (Fig. 29), is a bowl of brown ware, representing a frog. Vessel No. 77 from the ground south of Mound D (Fig. 30), a bottle, gives a life-like representation of the same animal.

Vessel No. 95 from the ground south of Mound D (Figs. 31, 32), is a bottle with a curious engraved decoration.

Vessel No. 21 from the ground south of Mound D, is a bowl of coarse, brown ware (Fig. 33), shown here only on account of its artistic, claw-shaped handles.

Vessel No. 93 from the ground south of Mound D, is a water-bottle (Figs. 34, 35, 36), having for decoration on two opposite sides our old Moundville acquaintance, the ivory-bill woodpecker having two heads, a

FIG. 29.—Vessel No. 1. Field west of Mound N. (Maximum diameter 7.7 inches.)

FIG. 30.—Vessel No. 77. Ground south of Mound D. (Height 5.8 inches.)

body in common, and two tails at right angles from the body, thus perhaps forming a cross of the four directions. The extended tongue and speech-symbols issuing from the mouth, so often found on woodpecker designs, are absent in this instance.

Vessel No. 86 from the ground south of Mound D, a bowl (Figs. 37, 38), has an engraved decoration spread over the base and sides, representing the ivory-bill woodpecker with wings extended. The bird is shown propped with the aid of its tail, as is the case when the woodpecker is at work. The tongue is

FIG. 31.—Vessel No. 95. Ground south of Mound D. (Height 7.2 inches.)

extended; speech-symbols are shown issuing from the mouth. We believe this entire design to be unique.

Vessel No. 5 from the field near Mound M, is a part of a bowl (Figs. 39, 40) having a seven-pointed star on the base and various interesting symbols around the sides.

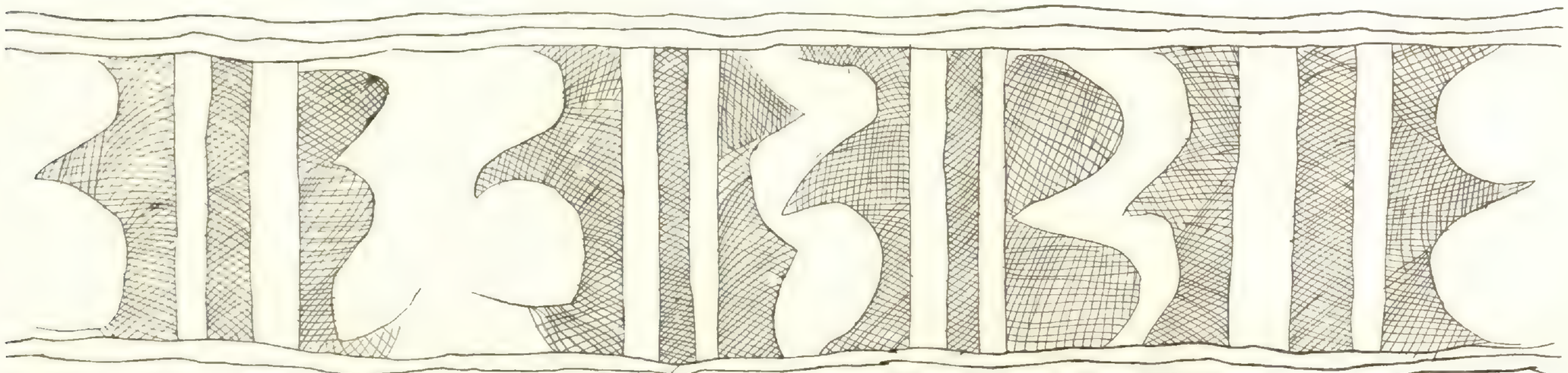


FIG. 32.—Vessel No. 95. Decoration. (About one-third size.)

Vessels No. 13 from the ground south of Mound D, and No. 28 from the field west of Mound R (Figs. 41, 42, respectively), are water-bottles each bearing a somewhat similar and evidently symbolic design, but its nature we are unable to determine.

FIG. 33.—Vessel No. 21. Ground south of Mound D. (Diameter 6.5 inches.)

FIG. 34.—Vessel No. 93. Ground south of Mound D. (Height 5.5 inches.)

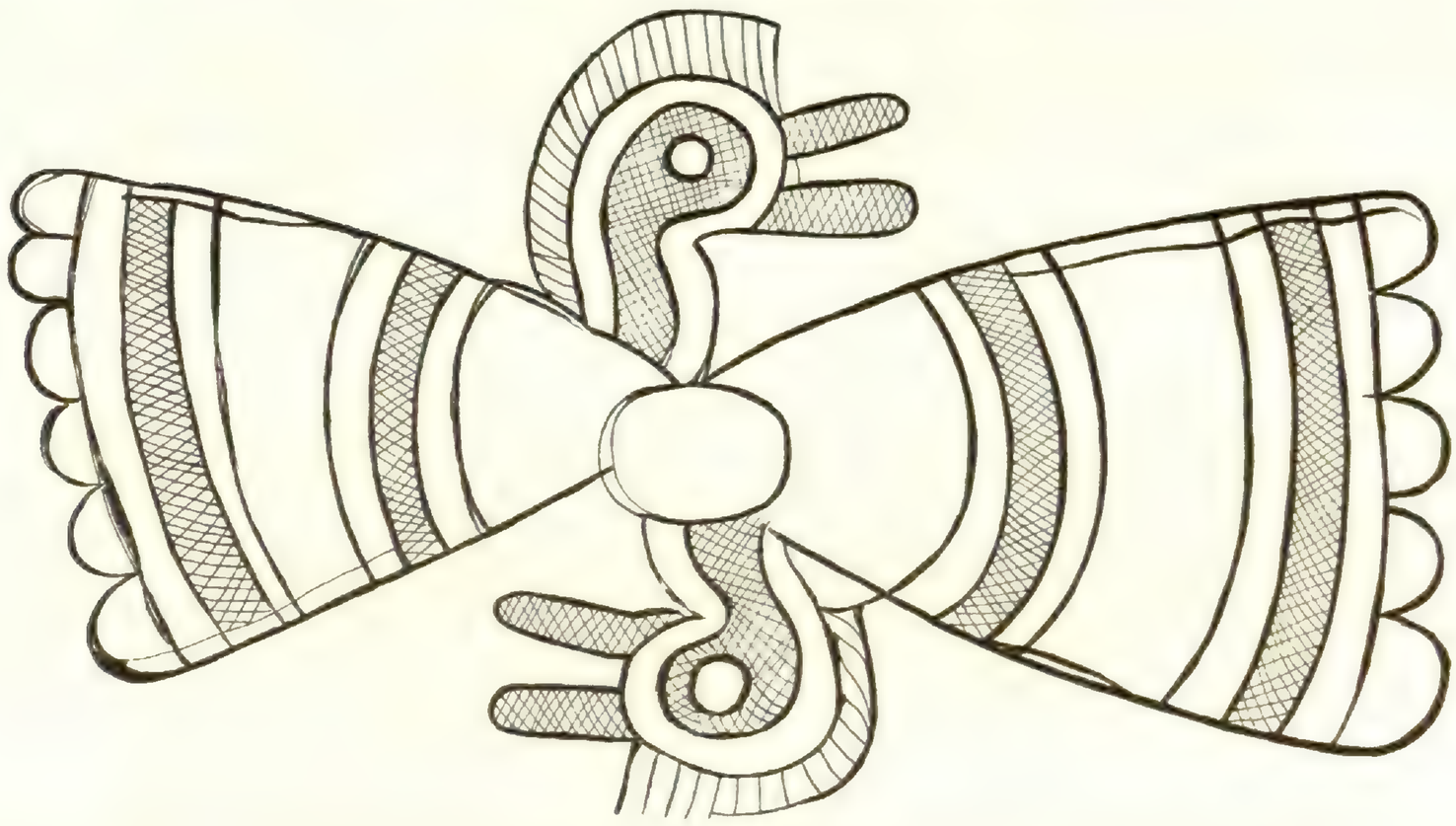


FIG. 35.—Vessel No. 93. Decoration showing ivory-bill woodpecker design. (About two-thirds size.)

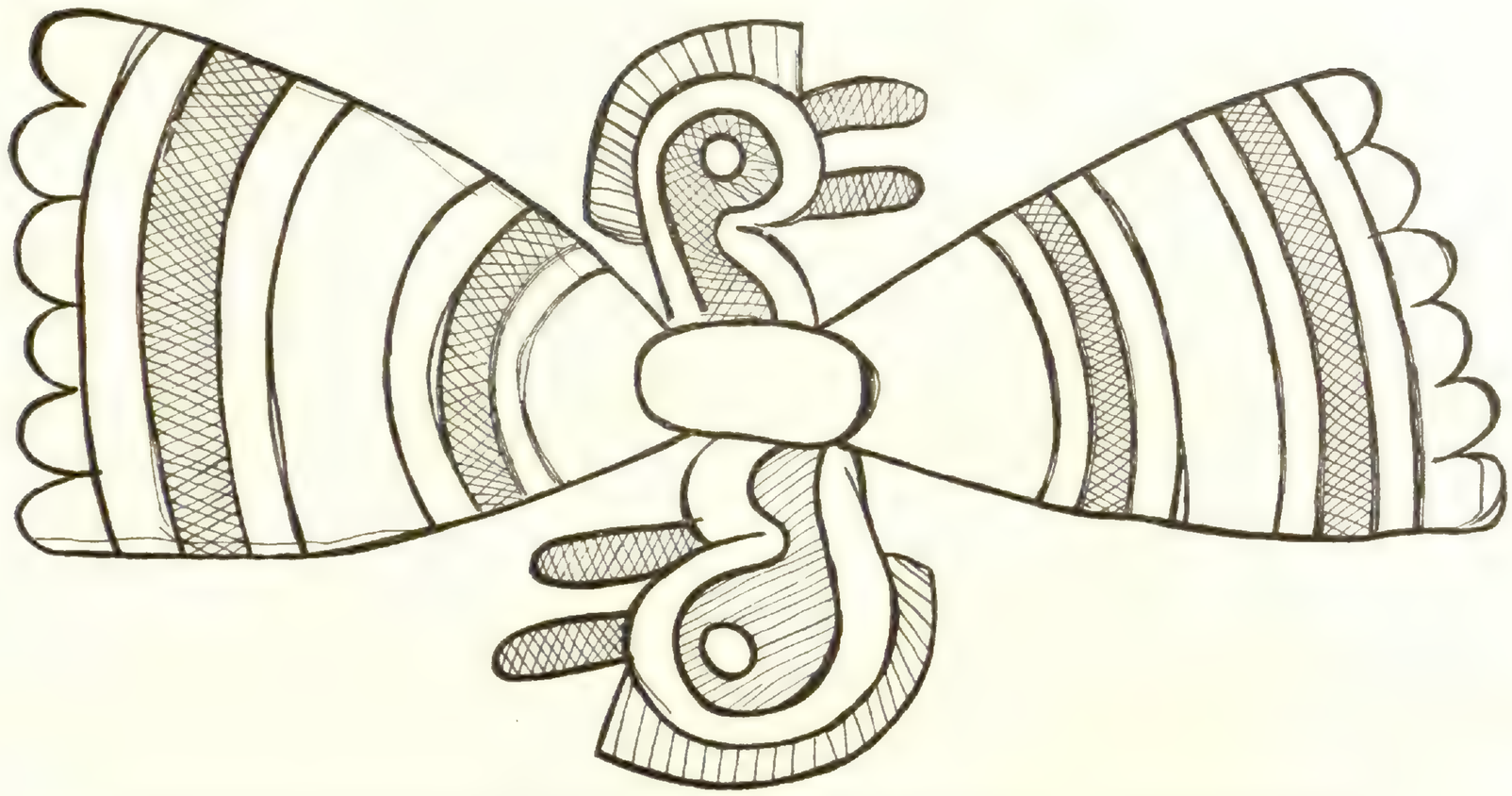


FIG. 36.—Vessel No. 93. Decoration showing ivory-bill woodpecker design. (About two-thirds size.)

FIG. 37.—Vessel No. 86. Ground south of Mound D. The ivory-bill woodpecker. (Diameter 4.5 inches.)

FIG. 38.—Vessel No. 86. Decoration. (About two-thirds size.)

FIG. 39.—Vessel No. 5. Field near Mound M. (About full size.)

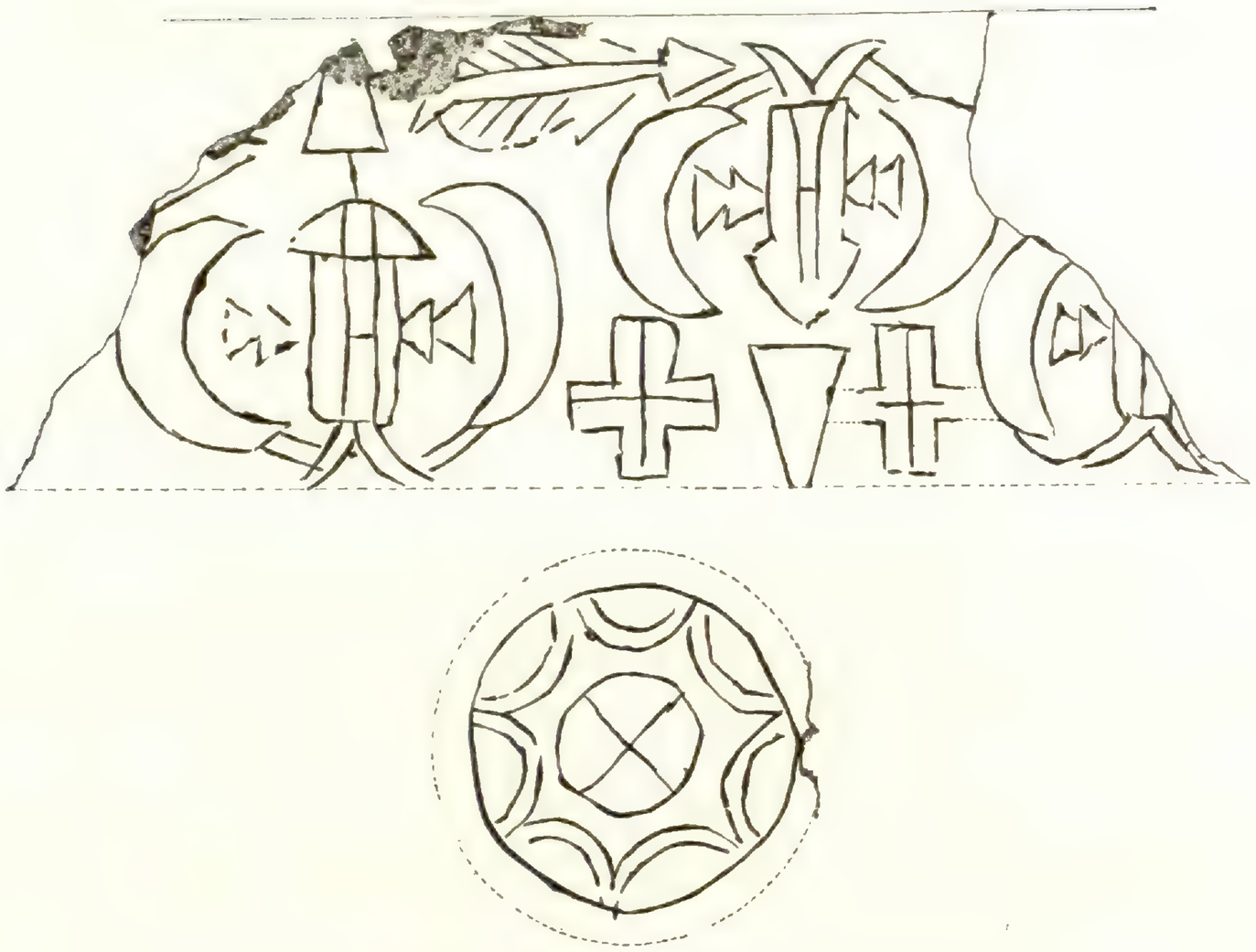


FIG. 40.—Vessel No. 5. Decoration. (About two-thirds size.)

FIG. 41.—Vessel No. 13. Ground south of Mound D. (Height 7.3 inches.)

Vessel No. 48 from the ground south of Mound D, is a bowl (Figs. 43, 44) the base and sides of which are completely covered with figures possibly representing bows and arrows. If the rosette-like figures are sun-symbols (and the sun is thus represented sometimes, we believe), the design may have been intended to represent the arrows or shafts of the sun. This, of course, is conjecture.

Vessels No. 88 from the ground south of Mound D, and No. 15a from the field near Mound M, are bottles (Figs. 45, 46, respectively), each having a design four times shown, consisting of a skeleton hand (probably) and a skeleton forearm. In

FIG. 42.—Vessel No. 28. Field west of Mound R. (Height 4.8 inches.)

our former Moundville report we described and figured (pp. 175 and 226) two vessels bearing engraved representations of skulls and skeleton forearms, and called attention to the resemblance between these and certain figures in Mexican codices. We were unable at that time, however, to cite a case in the codices where the ramus of the lower jaw is shown extending so markedly behind the occipital part of the skull as it is made to do in the Moundville designs. We are now able to a certain extent to supply the deficiency from the Sahagun manuscript.[1]

[1] "*Altmexikanischer Schmuck und soziale und militärische Rangabzeichen,*" Fig. 63. Prof. Dr. Eduard Seler. *Gesammelte Abhandlungen.*

FIG. 43.—Vessel No. 48. Ground south of Mound D. (Diameter 5.6 inches.)

FIG. 44.—Vessel No. 48. Decoration. (About half size.)

Vessel No. 1 from the field near Mound M, is a bottle of artistic outline (Fig. 47) with an incised design which is perhaps a variant of the leg-symbol.

FIG. 45.—Vessel No. 88. Ground south of Mound D. Design of hand and skeleton forearm. (Height 5.5 inches.)

Vessel No. 109 from the ground south of Mound D, is a bottle without decoration (Fig. 48), shown here on account of its graceful form.

Vessel No. 59 from the ground south of Mound D, a bottle (Figs. 49, 50) with engraved design twice shown, representing wings of an eagle or of the plumed or horned serpent.

Vessel No. 6 from the ground south of Mound D, a bottle (Figs. 51, 52, 53), bears engraved on two opposite sides representations of the winged rattlesnake, in this case without horns, crest, or plumes. Leg-

FIG. 46.—Vessel No. 15*a*. Field near Mound M. (Height 5.5 inches.)

FIG. 47.—Vessel No. 1. Field near Mound M. (Height 7 inches.)

FIG. 48.—Vessel No. 109. Ground south of Mound D. (Height 6.9 inches.)

FIG. 49.—Vessel No. 59. Ground south of Mound D. Design of eagle or serpent wings. (Height 5 inches.)

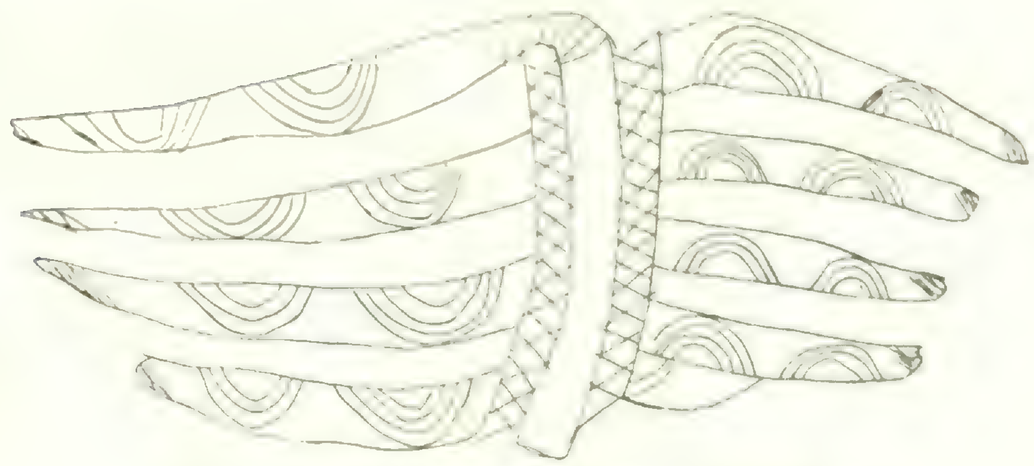


FIG. 50.—Vessel No. 59. Decoration. (About half size.)

FIG. 51.—Vessel No. 6. Ground south of Mound D. Winged serpent design. (Height 6 inches.)

symbols, however, are clearly represented. The leg-symbols present on the winged serpent found by us on our first visit to Moundville (Fig. 152 of our report), and seen on some of the plumed serpent designs of Peru, is a most popular symbol on the pottery of the northwestern Florida region,[1] whence it extends somewhat northward,[2] and is even found incised in the open-work effigy-vessels.[3] Finally,

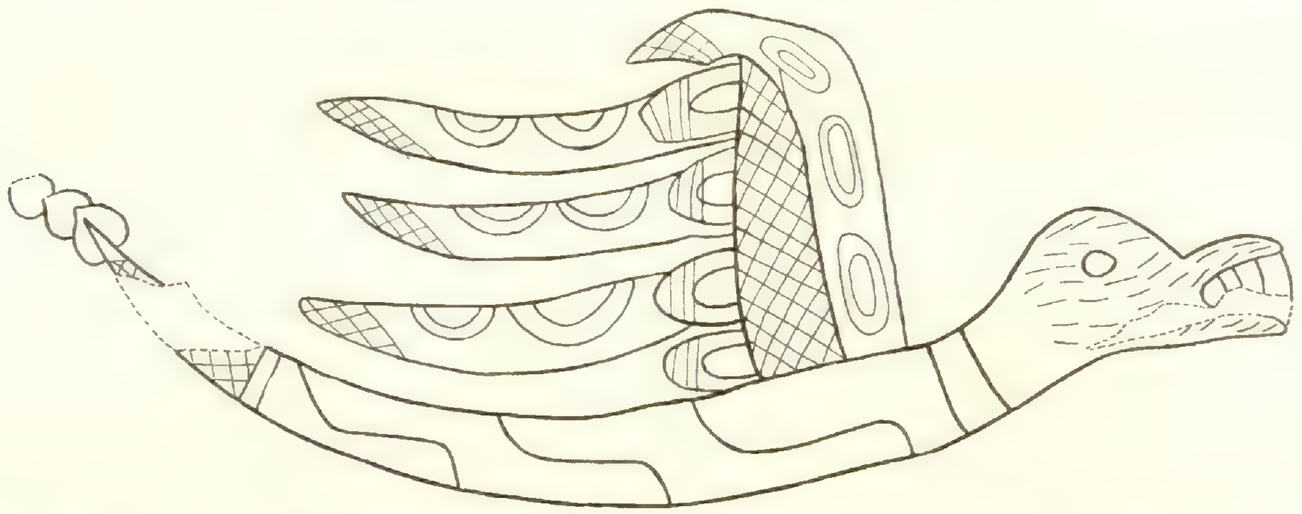


FIG. 52.—Vessel No. 6. Decoration showing winged serpent with leg-symbols. (About half size.)

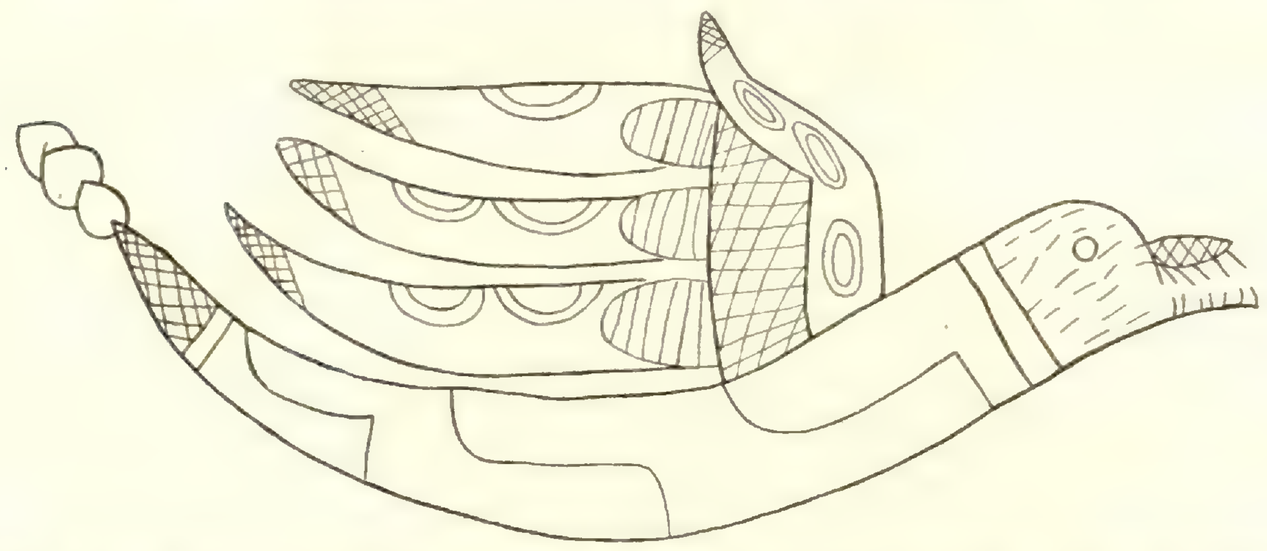


FIG. 53.—Vessel No. 6. Decoration showing winged serpent with leg-symbols. (About half size.)

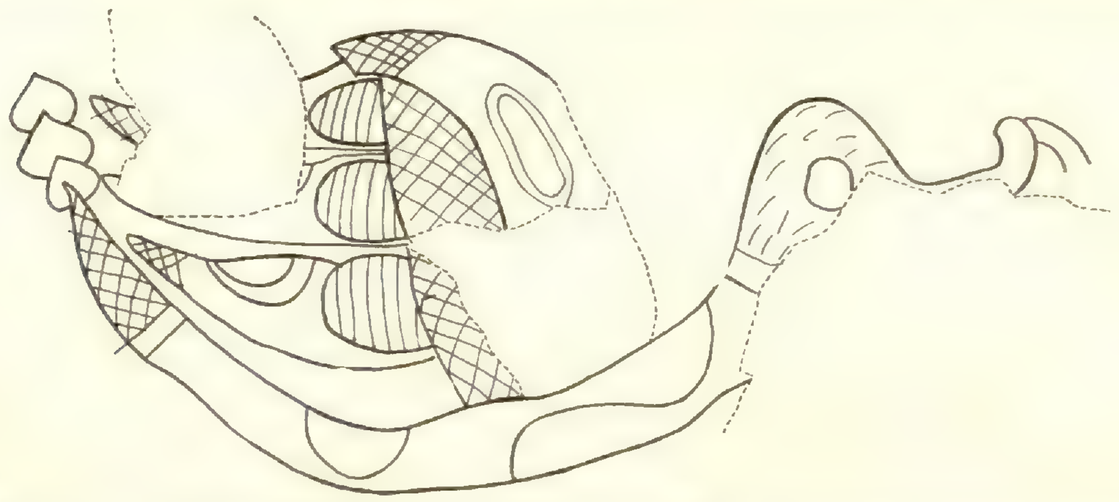


FIG. 54.—Vessel No. 1. Ground south of Mound D. Decoration showing the winged serpent. (About half size.)

[1] "Aboriginal Remains of the Northwest Florida Coast," Parts I and II. Journ. Acad. Nat. Sci. of Phila., Vols. XI and XII, respectively.

[2] "Mounds of the Lower Chattahoochee and Lower Flint Rivers," Figs. 15 and 16. Journ. Acad. Nat. Sci. of Phila., Vol. XIII.

[3] *Ibid.* Fig. 8.

FIG. 55.—Vessel No. 1. Ground south of Mound D. Decoration showing the winged serpent. (About half size.)

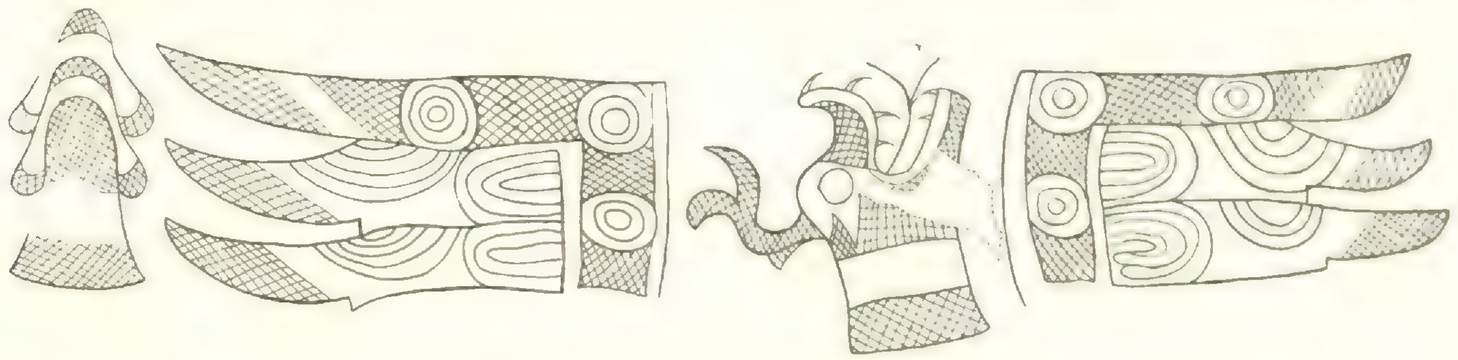


FIG. 56.—Vessel No. 34. Ground south of Mound D. Decoration showing head, wings and tail of the horned or plumed serpent. (About one-third size.)

FIG. 57.—Vessel No. 33. Ground south of Mound D. (Height 5.8 inches.)

we find the symbol used apart from the animal and placed around vessels as an ornament simply[1]—this custom reaching far down the Florida coast.[2]

Vessel No. 1 from the ground south of Mound D, is a bottle found in so many fragments (some of which are missing), that it is not deemed worthy of reproduction here. The engraved decoration, however (Figs. 54, 55), a winged rattlesnake on two opposite sides of the vessel, without horns or plumes, has been carefully traced out and is presented as it appears.

Vessel No. 34 from the ground south of Mound D, is a water-bottle bearing an incised decoration (Fig. 56) showing the head, wings, and tail of the horned or

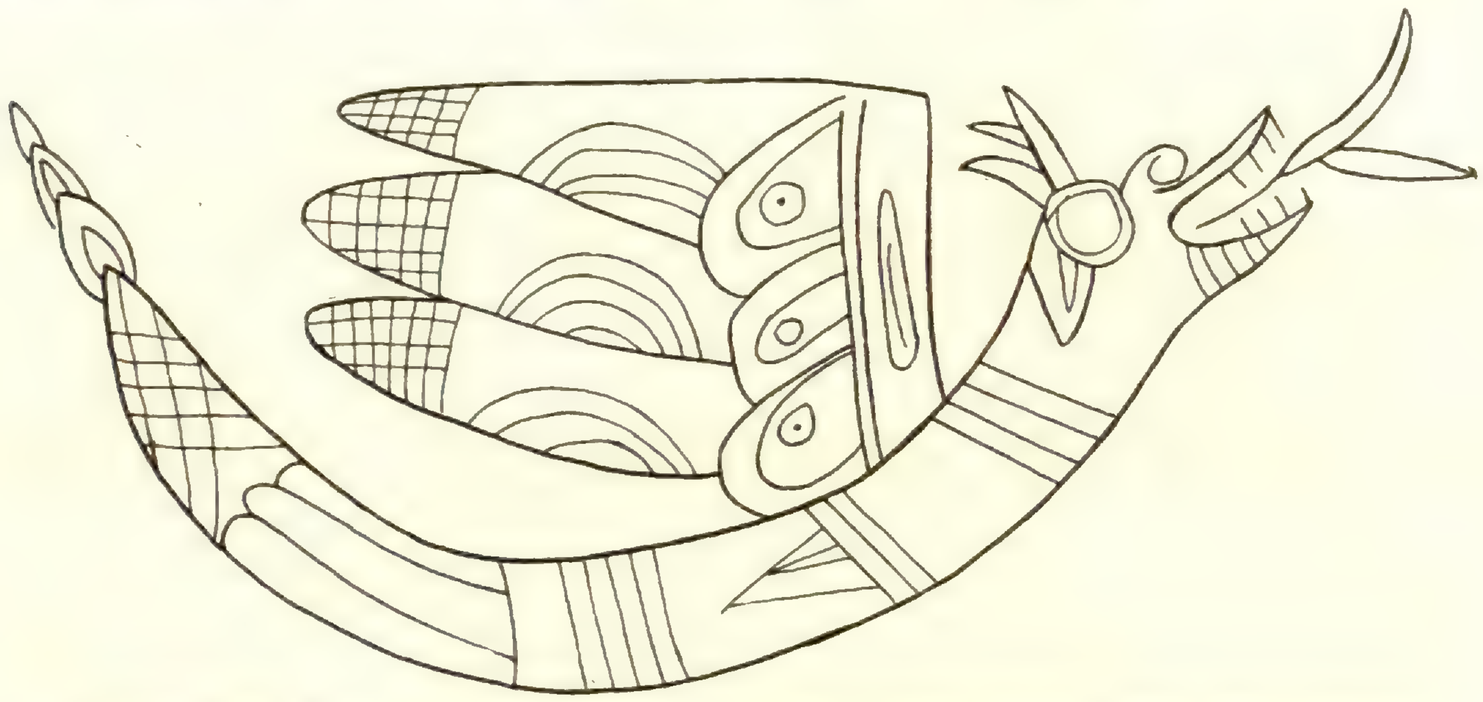


FIG. 58.—Vessel No. 33. Decoration showing the plumed or horned serpent. (About two-thirds size.)

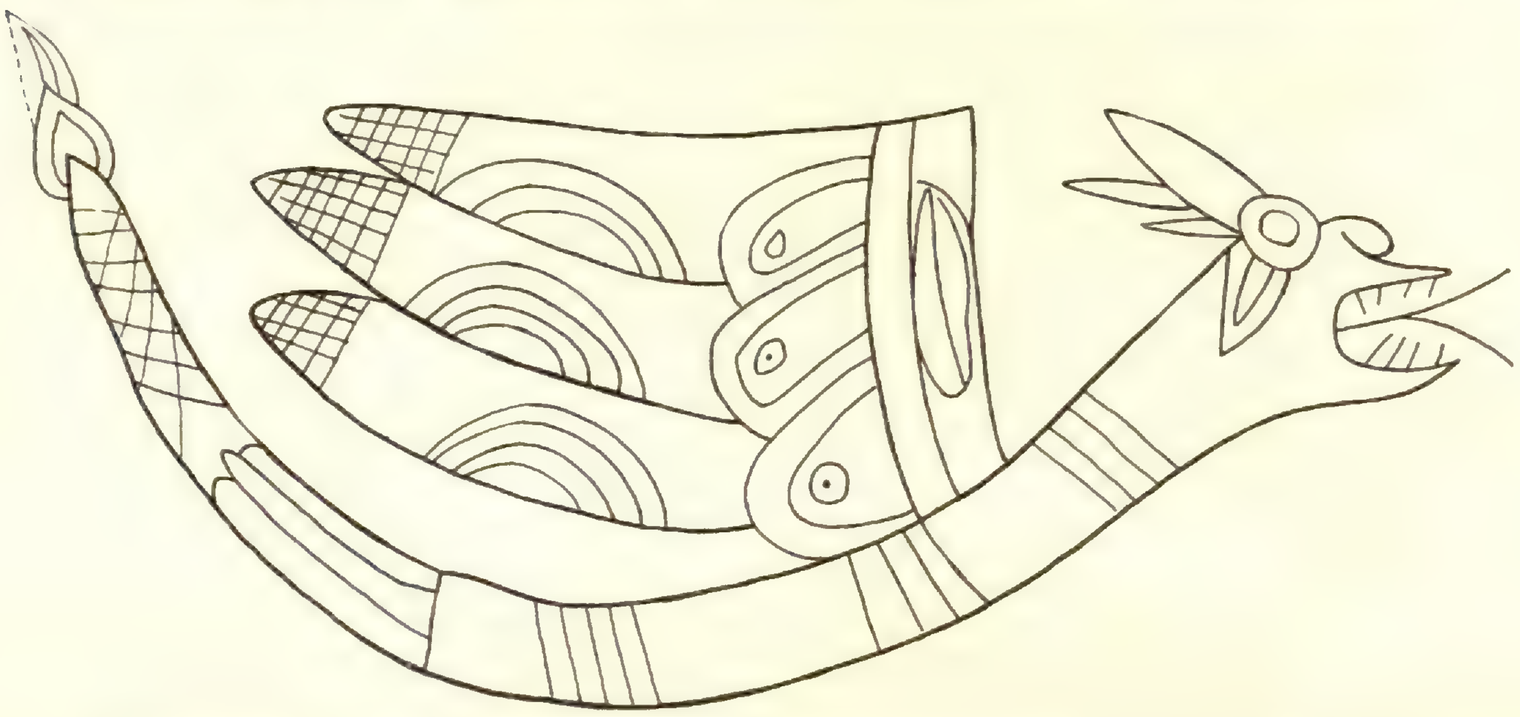


FIG. 59.—Vessel No. 33. Decoration showing the plumed or horned serpent. (About two-thirds size.)

plumed serpent, displayed separately—a design similar in the main to one found by us on our first visit to Moundville.

Vessel No. 33 from the ground south of Mound D, is a bottle (Figs. 57, 58, 59) bearing two engraved representations of the horned or plumed serpent.

[1] Northwest Florida Coast, Part I, Figs. 7 and 25.
[2] "Miscellaneous Investigation in Florida," page 306. Journ. Acad. Nat. Sci. of Phila., Vol. XIII.

FIG. 60.—Vessel No. 42. Ground south of Mound D. (Height 7.4 inches.)

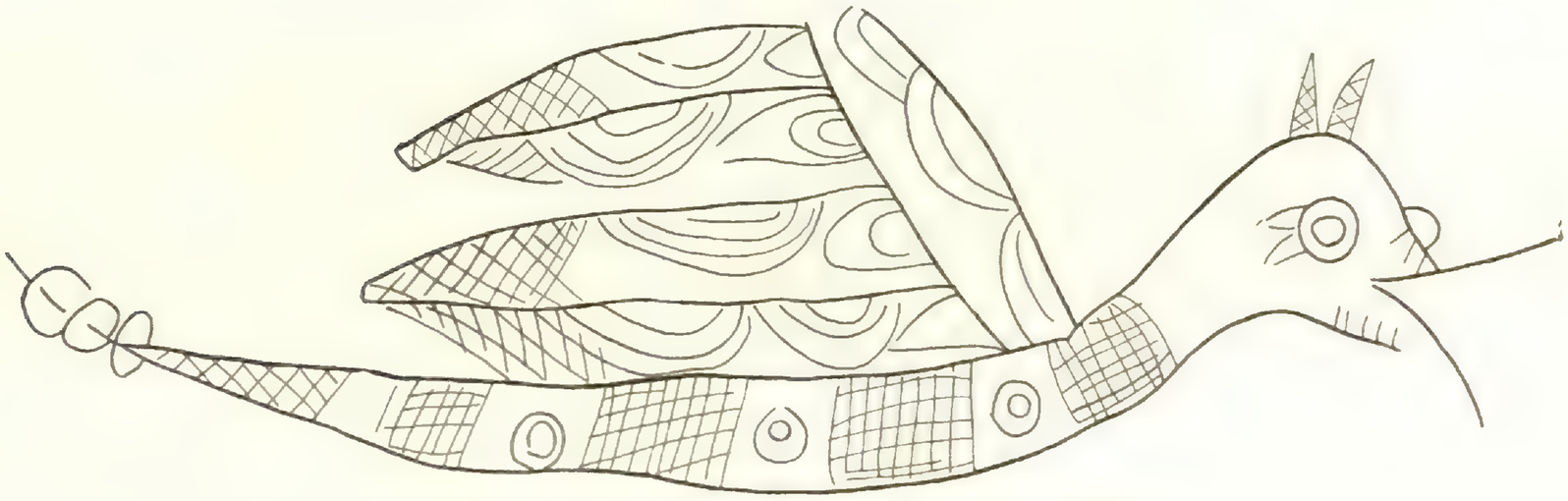


FIG. 61.—Vessel No. 42. Decoration. (About half size.)

Vessel No. 42 from the ground south of Mound D, is a bottle (Figs. 60, 61, 62) bearing around the neck marks of long-continued abrasion as by a cord for suspension. The decoration on two opposite sides consists of engraved representations of horned and winged rattlesnakes.

Vessel No. 87 from the ground south of Mound D, is a comparatively small bottle (Figs. 63, 64) having as engraved design a single winged serpent. This ser-

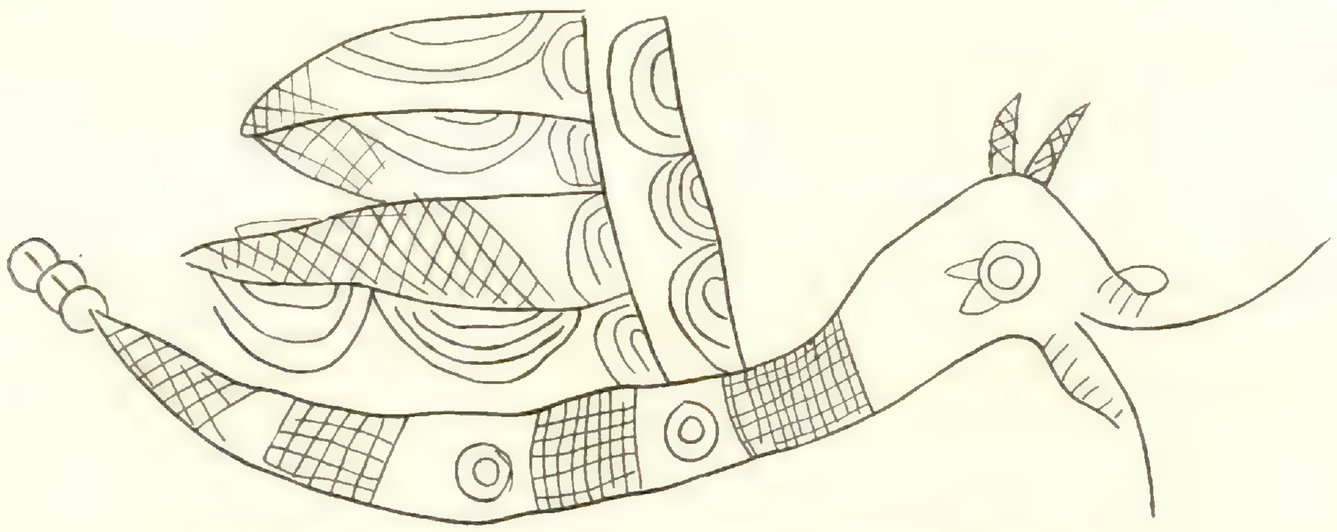


FIG. 62.—Vessel No. 42. Decoration. (About half size.)

FIG. 63.—Vessel No. 87. Ground south of Mound D. (Height 4.5 inches.)

pent is an interesting variant from others appearing on Moundville pottery, inasmuch as rattles are absent and the tail is that of a bird.

Vessel No. 44 from the ground south of Mound D, is a badly broken bottle carefully put together since its discovery. The engraved decoration (Fig. 65) is doubly interesting. In the first place, the tail of a bird is shown, to which rattles have been added. But the most noteworthy feature is that of the union of the two serpents around the vessel, being the first step toward a conventionalized, decorative serpent-design.

Vessel No. 8 from the ground south of Mound D, a water-bottle (Figs. 66, 67), shows the next step toward a conventionalized serpent-design. Here we see partly-interlocked scrolls decorated with the crest of the serpent. It is interesting to note that Professor Holmes, in an early report of the Bureau of Ethnology,[1] says

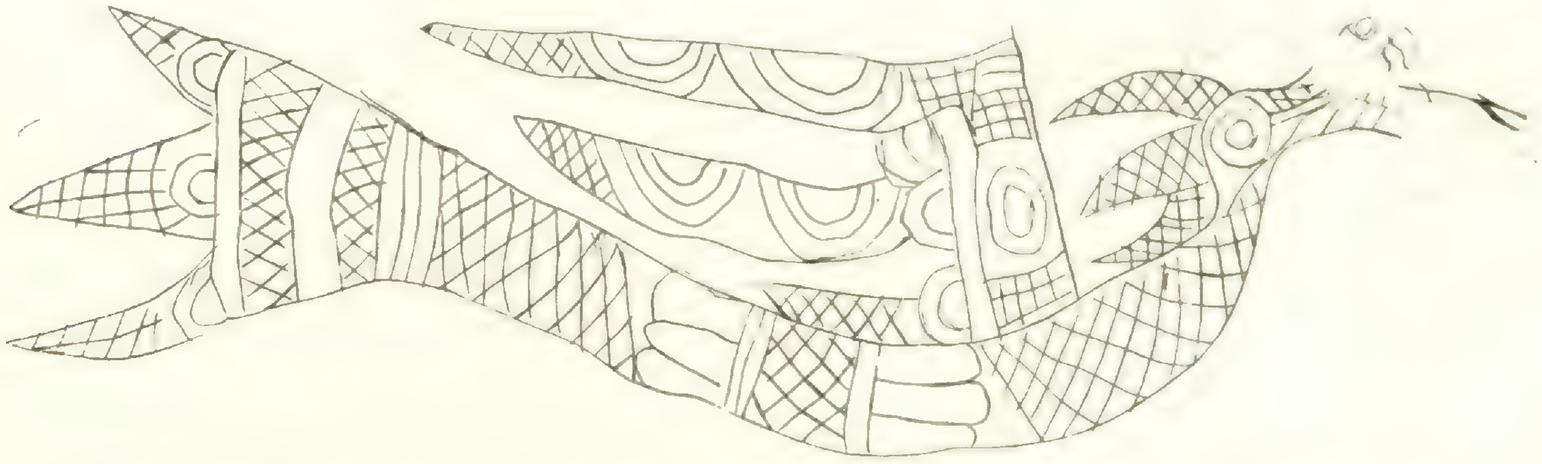


FIG. 64.—Vessel No. 87. Decoration. Winged serpent with rattles replaced by bird's tail. (About half size.)

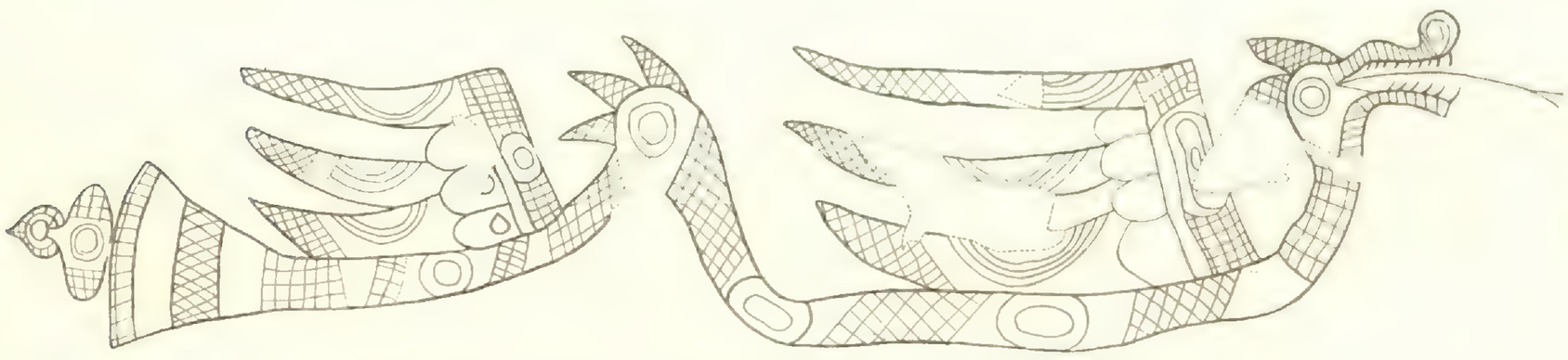


FIG. 65.—Vessel No. 44. Ground south of Mound D. Decoration showing the merging of the two serpents, being the first step toward a conventionalized design. (About one-third size.)

in relation to a vessel of the same character as the one we are describing, "The engraved design consists of four elaborate, interlinked scrolls, comprising a number of lines, and bordered by wing-like, triangular figures, filled in with reticulated lines. This latter feature is often associated with native delineations of mythic reptiles, and it is not impossible that this scroll work is a highly conventionalized form of some such conception." Vessels with designs kindred to the one in question are described in other works.[2]

[1] W. H. Holmes. "Ancient Pottery of the Mississippi Valley," p. 419, 1882-83.

[2] W. H. Holmes. An. Rep. Bur. Amer. Ethn., 1881-82, Fig. 149.
W. H. Holmes. An. Rep. Bur. Amer. Ethn., 1882-83, Fig. 440.
Also Plate XV, Fig. c. Report of 1898–99, where the figure is taken from the Report of 1882–83.
C. B. Moore. "Certain Aboriginal Remains of the Black Warrior River," Fig. 162.
Compare also tail-piece, page 33, "The Serpent Motive in the Ancient Art of Central America and Mexico," Dr. George Byron Gordon. Transactions Department of Archæology, University of Penna., Vol. I, Part III, 1905.

FIG. 66.—Vessel No. 8. Ground south of Mound D. (Height 5.3 inches.)

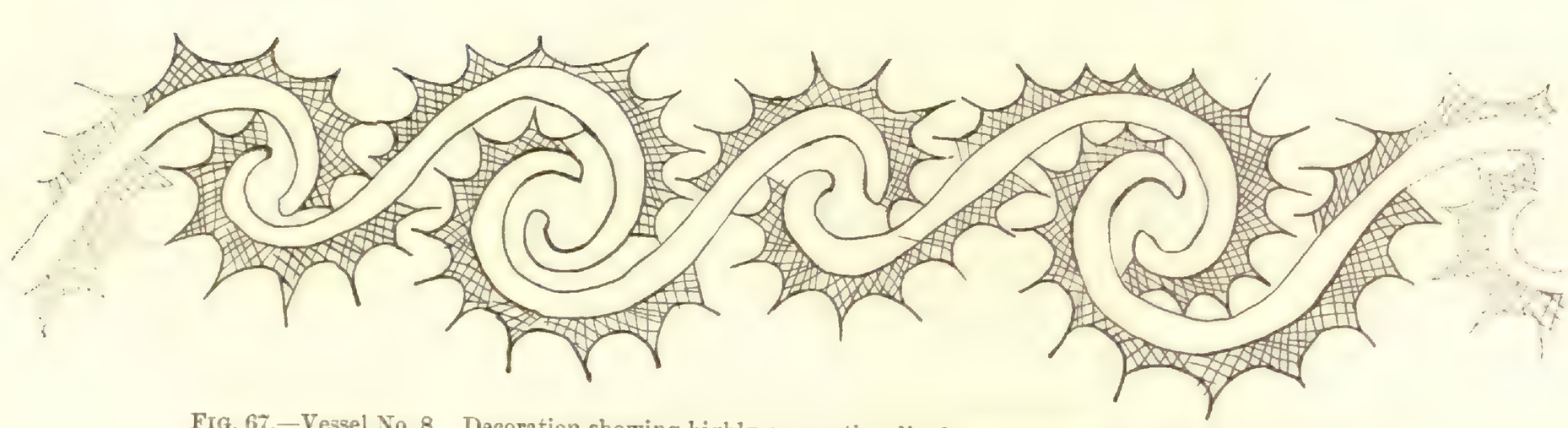


FIG. 67.—Vessel No. 8. Decoration showing highly conventionalized serpent-design. (About one-third size.)

Vessel No. 14 from the ground south of Mound D (Figs. 68, 69), bears another highly conventionalized serpent-design of partly interlinked scrolls and serpents' crests.

Vessel No. 96 from the ground south of Mound D, a bottle (Figs. 70, 71), bears another conventionalized serpent-decoration in which we see a lessening of the number of crests and a consequent tendency toward the partly-interlocked scroll pure and simple.

FIG. 68.—Vessel No. 14. Ground south of Mound D. (Diameter 4.8 inches.)

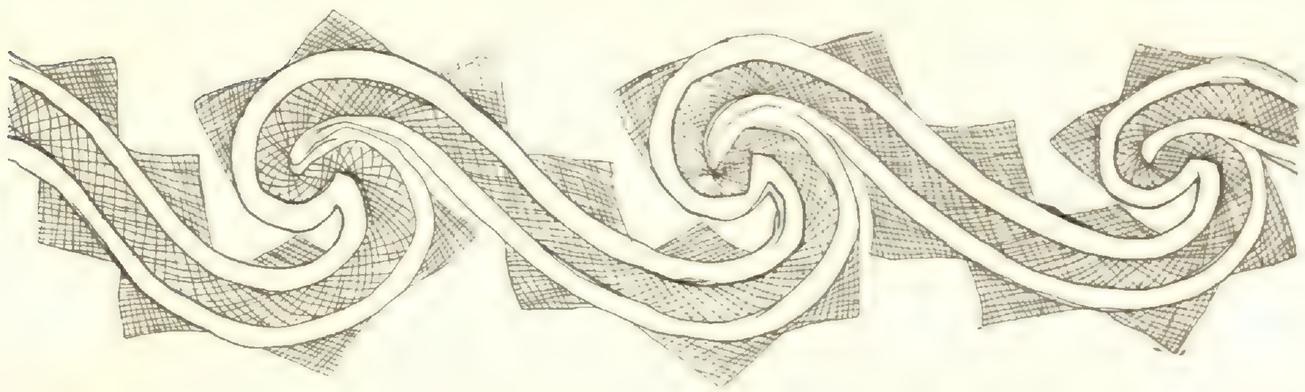


FIG. 69.—Vessel No. 14. Decoration showing highly conventionalized serpent-design. (About one-third size.)

Vessel No. 3 from the field west of Mound R, a very graceful water-bottle (Fig. 72), bears the partly-interlocked scroll without the serpents' crests, the ultimate stage in the evolution from the serpent-design.

Vessel No. 6 from the field near Mound M, a water-bottle, bears a decoration shown in Fig. 73, where again we see the partly-interlocked scroll free from the serpent-crest decoration.

FIG. 70.—Vessel No. 96. Ground south of Mound D. (Height 5 inches.)

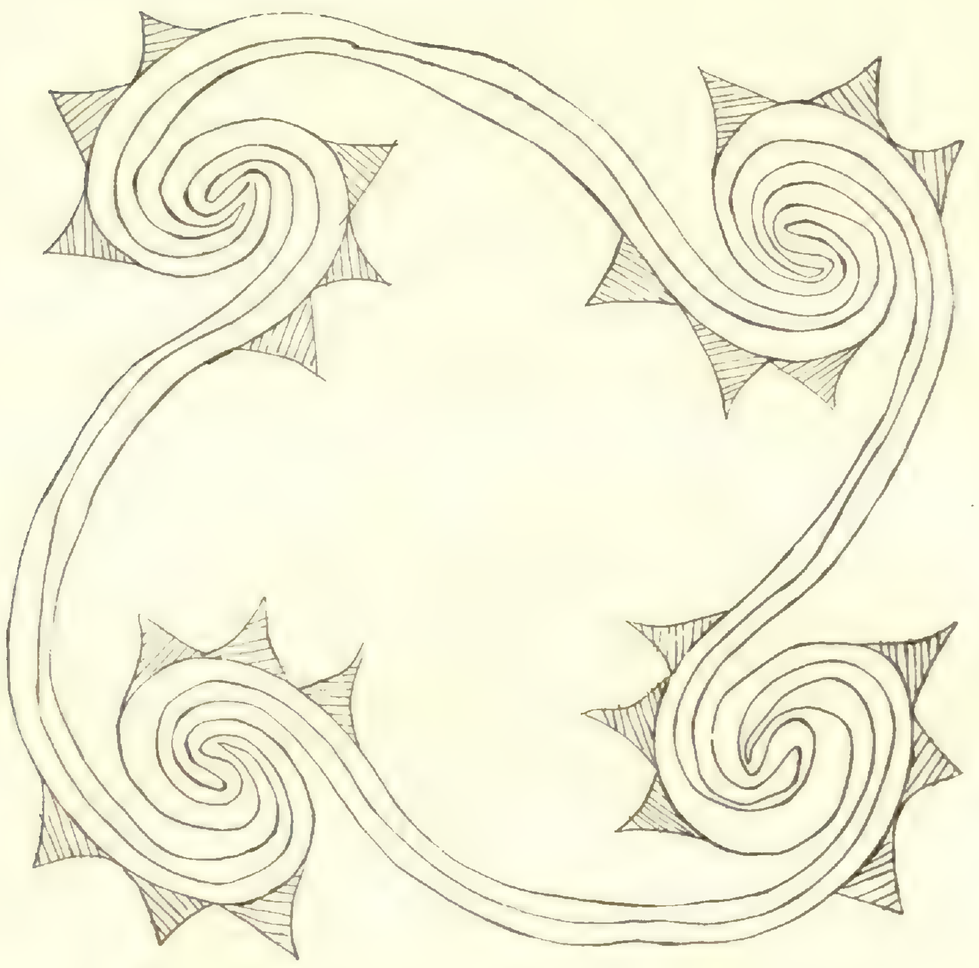


FIG. 71.—Vessel No. 96. Decoration showing highly conventionalized serpent-design. (About half size.)

FIG. 72.—Vessel No. 3. Field west of Mound R. Partly interlocked scroll, or serpent-design. (Height 8.4 inches.)

BONE OBJECTS.

Throughout the second investigation at Moundville many implements of bone were found, some with the articular part remaining—these latter being usually from the ulna of the deer. A selection of bone implements from Moundville is shown in Fig. 74, including one with a chisel edge.

Also were found several canines of large carnivores, pierced for suspension;

tines of deer-antlers, used as arrowheads; knuckle bones of deer; a part of a bone needle with an eye.

With fragments of animal bones were a humerus of the Virginia deer and part of the upper jaw of the black-bear, probably *Ursus americanus*. We are indebted to Prof. F. A. Lucas for these identifications.

The finding of the incisor of a beaver will be referred to elsewhere in this report.

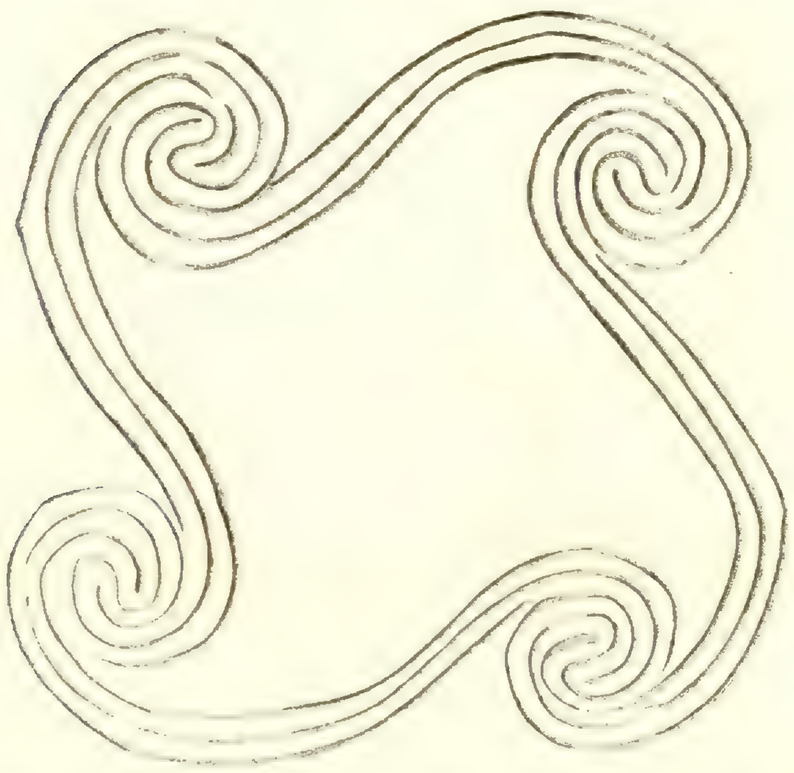


FIG. 73.—Vessel No. 6. Field near Mound M. Decoration showing highly conventionalized serpent-design. (About one-third size.)

In the ground south of Mound D, apart from human remains and widely separated, were two femurs belonging to two bears of different size—both young, as the epiphyses were not attached. The shafts of these femurs are highly polished as by long and energetic use. In the same position in each is a deep depression which could have been made by friction with the thumb through a long period of time. Just such a depression has been worn on the hard-wood handle of the trowel which has been in use for years in our expeditions, which also shows the high polish seen on the shafts of the femurs. The great trochanter of each femur is rounded and worn to some extent as by gentle use material—a pad of soft hide, perhaps, or with more vigorous treatment under soft as Professor Putnam has suggested to us.

A complete description of these bones (one of which is shown in Fig. 75) was sent to the National Museum, which courteously reported that no similar objects were in its collection. Archæologists consulted by us have no suggestions to offer other than our own belief that the femurs are drum-sticks. The high polish and the grooves can well be accounted for if we bear in mind the frenzied beating of the medicine-man, continued over long periods; and the light wear on the great trochanters resulted no doubt from use under a soft covering intended for protection of the head of the drum.

STONE OBJECTS.

At our first visit to Moundville we found a large vase of diorite, beautifully carved—a triumph of aboriginal endeavor.

At our second visit, with burial No. 77, an adult lying at full length on the back in the ground south of Mound D, we unearthed a stone bowl in many fragments, all of which, fortunately, were recovered and have been cemented together (Figs. 76, 77, 78, 79).

FIG. 74.—Bone implements. Moundville. (Full size.)

FIG. 75.—Femur of bear, probably used as drum-stick. (Length 14.75 ins.)

The measurements are as follows: height, 4 inches; diameter with neck and tail, 13.75 inches; diameter of bowl, 9 inches.

The material is a hard, white limestone which must have offered considerable resistance to the carver's tool, though at present the surface of the vessel has deteriorated greatly through lapse of time, being soft and yellow in color.

The vessel, which is intended to represent a bird, has the neck and head extended from the side of the bowl and running parallel with it to unite again with the bowl at the tip of the bill. The wings, feathers and claws of the bird are skilfully incised on the sides of the bowl and on part of the base. The tail projects almost at right angles.

The bird here represented seems to be somewhat of a nondescript. According to Mr. Witmer Stone of the Academy of Natural Sciences, judging from the crooked beak and the talons, a bird of prey is represented, having a somewhat unduly elongated neck to afford ample size for the handle. The wattle, presumably, is an addition to please the fancy of the artist, though a somewhat similar wattle, but placed farther forward, is found on the king vulture (*Gypagus papa*), whose northernmost habitat, however, is southern Mexico.

This vessel, when snow-white and intact, must have been indeed a striking example of aboriginal work and worthy of the ancient art of Moundville.

Burials Numbers 58 and 59, in the ground south of Mound D, two skeletons of adolescents at full length on the back, side by side, one with a few pentagonal and hexagonal shell beads, had lying between them, near the waists, a superb pipe of limestone, representing an eagle. This pipe, 4.6 inches in length, carved with great spirit, is a worthy exemplar of the prehistoric art of Moundville (Figs. 80, 81, 82, 83, 84, 85, 86). The bird is represented on its back, the head swung around to one side with the beak open and tongue extended.

FIG. 76.—Bowl of limestone. (Maximum diameter 13.75 inches.)

FIG. 77.—Bowl of limestone, viewed from above.

FIG. 78.—Bowl of limestone, viewed from below.

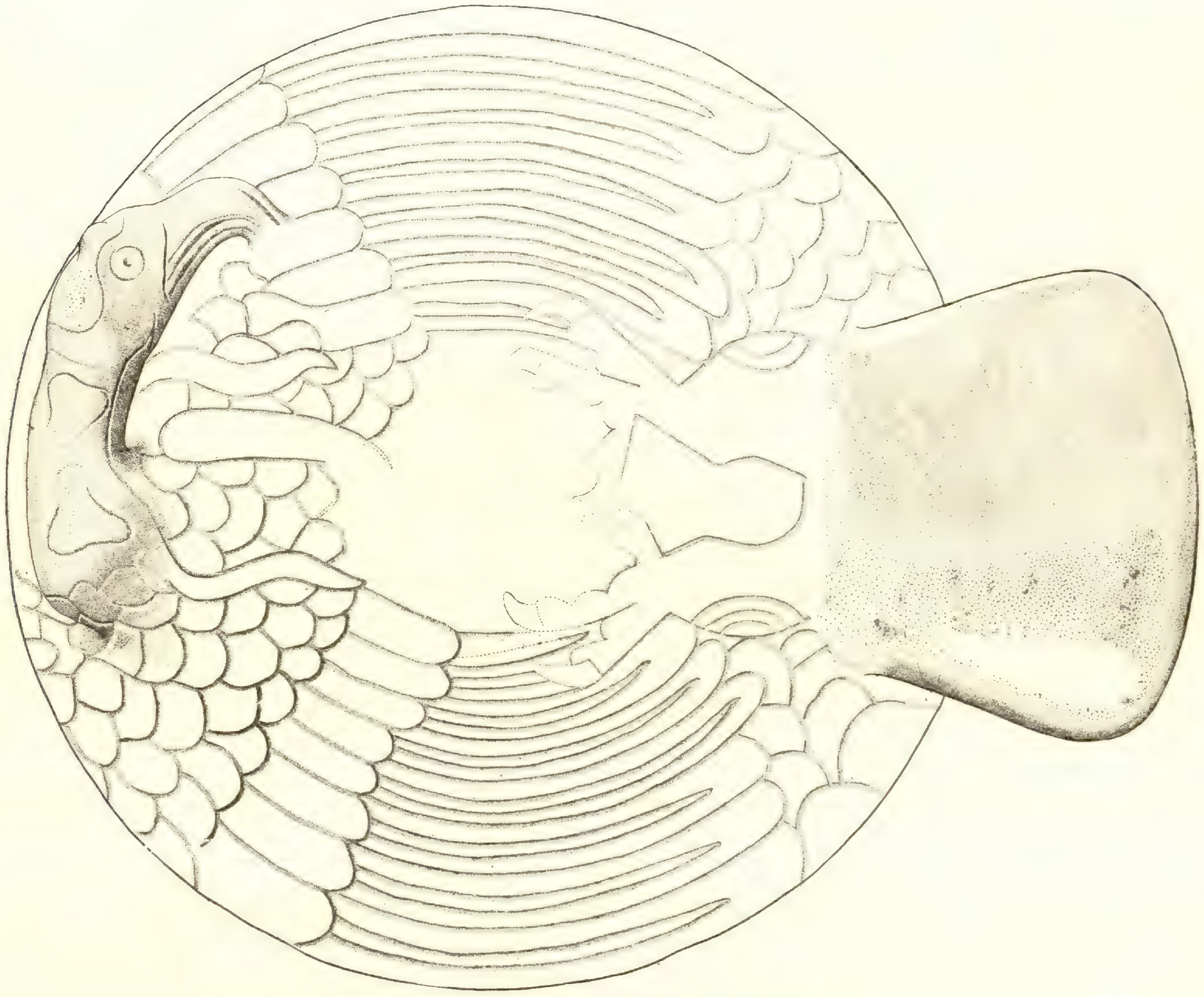
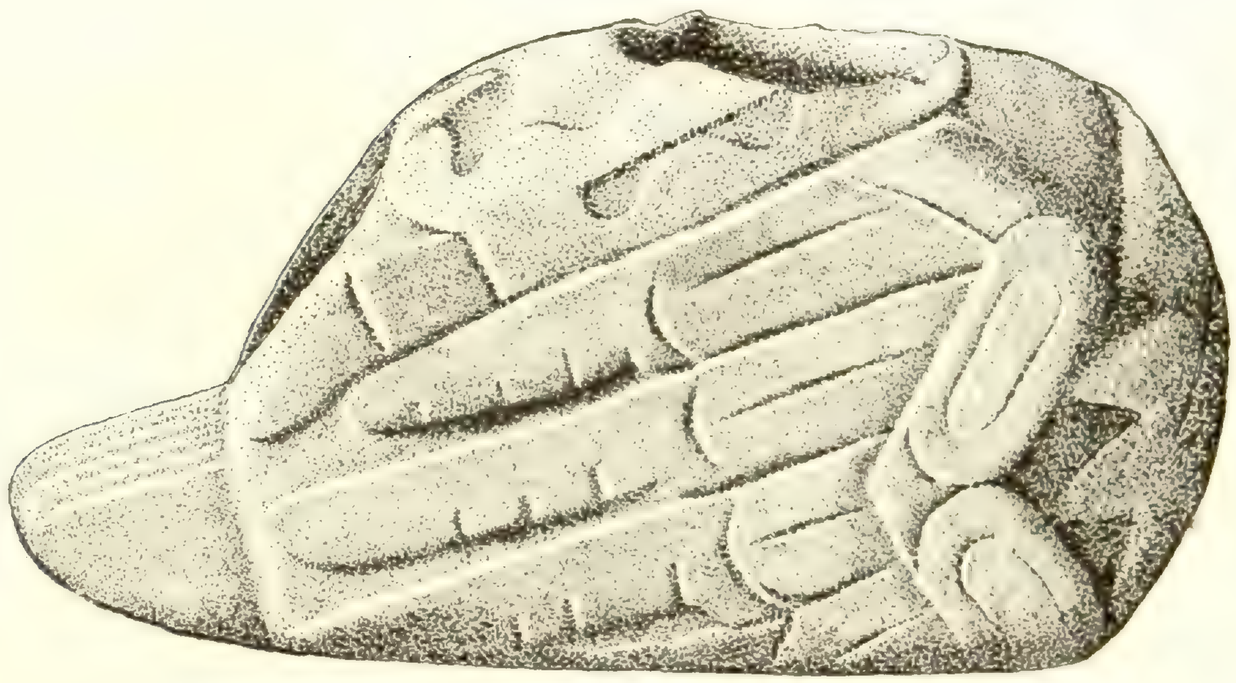


FIG. 79.—Bowl of limestone. Decoration of sides and base.

FIG. 80.—Pipe of limestone, representing an eagle. Moundville. (Length 4.6 inches.)

FIG. 81.—Eagle-pipe. Another view.

FIG. 82.—Eagle-pipe. Another view.



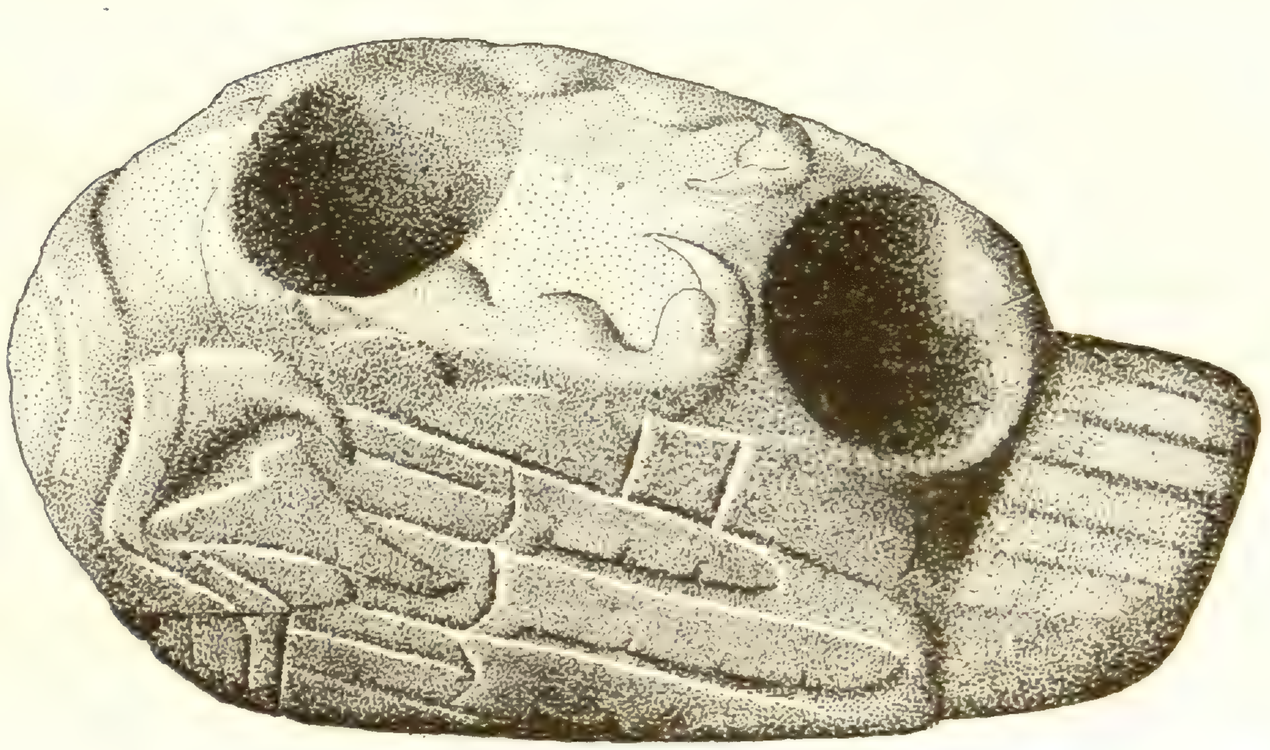


FIG. 83.—Eagle-pipe. Decoration. (Full size.)

FIG. 84.—Eagle-pipe. Decoration. (Full size.)

FIG. 85.—Eagle-pipe. Decoration. (Full size.)

Incidentally, it may be said that the "hump" shown on the tongue by the native artist, though somewhat exaggerated, is not imaginary, as may be proved upon examination of an eagle. It may be that this pipe, showing as it does the eagle lying upon its back, its legs and claws on the belly, represents the dead bird. By pulling out the tongue of a dead eagle one would be certain to notice the "hump"; hence the examination of a dead bird would have sufficed so far as correct rendering on the pipe was concerned.

On the other hand, the "hump" on the tongue is plainly shown on pottery from Moundville, where the eagle's head is erect and the bird is evidently represented as alive. Several experts who have charge of eagles in captivity inform us that under certain circumstances the "hump" on the tongue is visible on the living bird. Possibly the aboriginal artist at Moundville was familiar with the characteristics of eagles through the possession there of captive birds—a custom observed among the Zuñi of New Mexico at the present time.

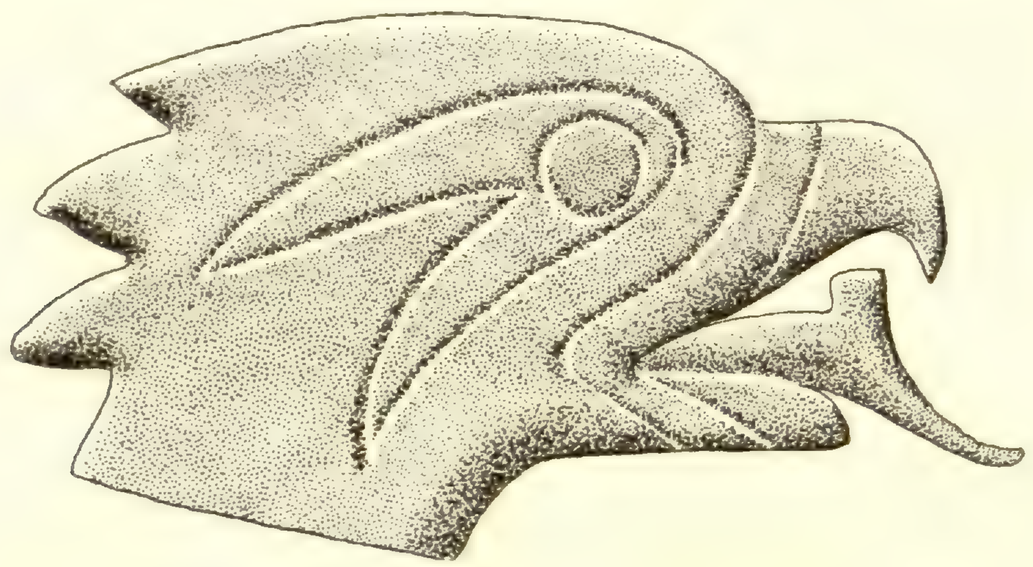


FIG. 86.—Eagle's head, from pipe, as it would appear on a flat surface. (Full size.)

Owing to slight disintegration of the stone at that part of the pipe where the head is, the details of the carving are somewhat indistinct, but by holding the pipe in a suitable light all the details of the head are still distinguishable. A wing is represented on each side. The legs, beginning at the tail, which extends outward, rise upward and forward, the feet and talons resting on the belly and embracing the orifice of the bowl. The opening for the stem is immediately above the tail.

The limestone of which the pipe is made is undoubtedly the same as that of the stone vessel which we have just described—compact and hard within, snow-white originally.

Three half-tone pictures of this pipe were sent by us to Mr. Joseph D. McGuire, who writes of the pipe as follows:

"The specimen is *sui generis* but apparently belongs to the bi-conical type found commonly in the States of Tennessee, Arkansas, etc. The material is unusual from which to make a pipe, but the Indians on occasion used anything, whether suitable or not.

"This pipe deserves a place to itself and I congratulate you as to its possession.

"The pipes of what I have called the bi-conical type are in my paper[1] (pages 538–39, etc.) though some of the features of this specimen are not entirely unlike those on pages 438–39, though your specimen to me has an elaboration of feather-work which has a Mexican appearance.

"I know of no pipe at all resembling the one you have more than to say it belongs to the type of bi-conical pipes."

FIG. 87.—Ceremonial palette for paint. (Full size.)

Part of a limestone pipe of ordinary type lay with a burial which will be described in detail later in the report.

With the exception of these two pipes no others of earthenware or of stone were met with at our second investigation of Moundville.

Nine entire discs (in diameter from 11.5 to 4.5 inches) and five fragments,

[1] "Pipes and Smoking Customs of the American Aborigines," by Joseph D. McGuire. Report of the U. S. National Museum for 1897.

nearly all of fine grained sandstone, were found on our second visit to Moundville. None of these ceremonial palettes[1] bears any interesting decoration such as has been found on other palettes at Moundville and elsewhere. One very rude palette (Figs. 87, 88) has certain rough markings.

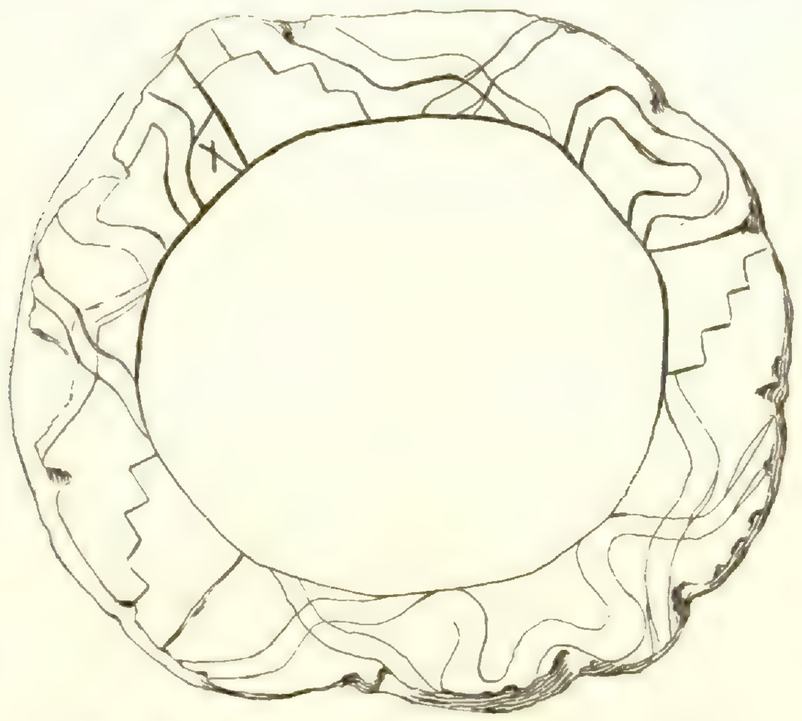


FIG. 88.—Design on palette. (About half size.)

Three fragments with marginal decoration differing somewhat from those found by us before are shown in Fig. 89.

On practically all the palettes was paint, sometimes red, sometimes white—the red being hematite; the white, white lead (lead carbonate). It may be remembered by those who have read our first report on Moundville that it is admittedly impossible for aborigines to have made white lead, and that the method by which they obtained it was by scraping from masses of galena (lead sulphide), such as we found at Moundville at both of our visits, the white lead (lead carbonate) which is a superficial transformation occurring on masses of lead sulphide. This material, mixed with bear's grease, would make an excellent paint.

FIG. 89.—Fragments of ceremonial palettes. (About half size.)

While at Moundville we found, sometimes in lumps with burials, or smeared on objects, red coloring matter which we felt must be hematite (red oxide of iron—the true aboriginal red paint). However, we decided on a chemical determination in addition to the analyses made in other seasons of red paint found under like conditions. The result, as we had supposed, showed the material to be hematite.

[1] This subject has been brought to date. "Certain Notched or Scalloped Stone Tablets of the Mound Builders," W. H. Holmes, Amer. Anthrop. Jan.–March, 1906.

FIG. 90.—Ceremonial axe of igneous rock. (Full size.)

With post-Columbian burials, however, the paint is not always the red oxide of iron. Once, in a low mound in Clay County, Florida, we found two skeletons with flint-lock muskets, lead bullets, etc. With these was a skeleton, evidently of a woman, having in one hand a bit of looking-glass and in the other a mass of red paint. Here we had to do with distinctly post-Columbian burials—very different from those of Moundville. The red paint proved to be cinnabar (mercury sulphide), which it is unlikely aborigines in the United States could have obtained before the coming of Europeans.

One mass of glauconite, "green earth" as it is called, was found on our second visit. This earth, which owes its color not to copper, but to iron in the ferrous state, may have served as a temporary paint, oxidation being likely to impair its color.

Two "hoe-shaped implements" of igneous rock were met with on our second visit, one with a burial, the other in ground aboriginally disturbed. One of these (Fig. 90) is of great beauty, having a convexity of blade and fluke-like projections below the shank in place of the usual ones which extend somewhat more at an angle.

The "hoe-shaped implement" is a ceremonial axe, as was recognized by many before the publication of our paper on the subject.[1]

At our second investigation at Moundville we found a beautiful little pendant of shell in the form of a battle-axe (figured under "Shell" in this paper), which clearly shows the blade to be the "hoe-shaped implement," even the method of fastening the blade to the handle being shown—thongs passing through the usual perforation in the stone to each side of the part projecting behind the handle. Another interesting feature of this little axe of shell is that a ring for suspension is provided at the end of the handle, as is the case with the superb monolithic axe and handle obtained by us at Moundville on our former visit.

Throughout the second investigation we found thirty-one discoidal stones—some with burials, but a larger number in the soil apart from human remains—ranging in diameter between 3.7 inches and .95 of an inch. Few are especially well wrought; none is perforated or cup-shaped. One of these discoidals is of lignite. Three seem to be hematite, but are of limonite with a thick coating of hematite, a natural formation after the making of the discoidal. One of these, on the base, shows an abandoned attempt to drill through, a partial perforation with a core being left. Another discoidal bears the decoration shown in Fig. 91.

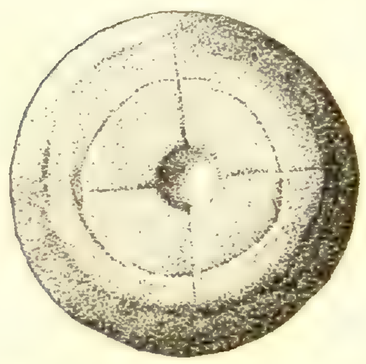


FIG. 91.—Discoidal stone. (Full size.)

Although there were found at Moundville quantities of fragments of "celts," some of which had been of considerable size when entire, no whole specimens of large size were met with by us. All we found were rather crudely made.

[1] "The so-called 'Hoe-shaped Implement.'" Amer. Anthropologist, July–September, 1903.

Six double-bladed implements—hatchets and chisels—were found, the majority apparently of fine-grained, igneous rock. One of these is shown in Fig. 92.

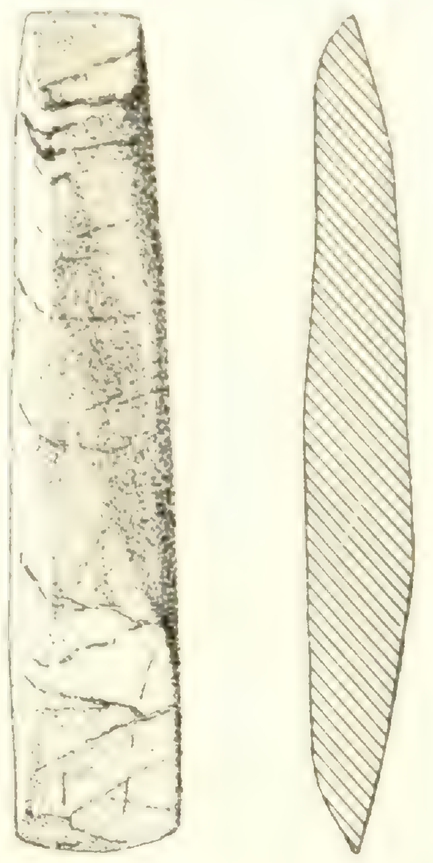


FIG. 92.—Double-bladed implement and section. (Full size.)

We have noted in the previous report the comparative absence of weapons at Moundville. The results of our second visit were confirmatory as to this.

A spear-head of chert, 6 inches in length, lay near the right forearm of a skeleton; and a fragment of a spear-head or of a dagger, more than three inches long, was unearthed.

Two small chert arrowheads were found, each near the skull of a skeleton; and four others lay near the knee of the skeleton of an adult fully extended on the back. This same skeleton, it may be said incidentally, had with the arrowheads many small fragments of chert; a water-bottle near the knee; along the right leg masses of hematite in a condition to use as paint. Another water-bottle was near the pelvis.

A neat little gorget (Fig. 93), probably of igneous rock, lay in the soil alone.

Fragments of mica lay with skeletons and alone in the soil. On each side of a skull was a disc of mica, 1.5 inches in diameter, centrally perforated—ear-plugs, no doubt.

No particular mention will be made of pebbles, pebble-hammers, chips of stone, hones of sandstone, etc., found scattered in the soil apart from burials. A multi-grooved sandstone hone lay near the skull of a skeleton.

FIG. 93.—Gorget. (Full size.)

A rude disc of inflammable material, probably from the nearby coal region, was found.

SHELL OBJECTS.

Owing to lapse of time or to other causes, objects wrought from shell at Moundville were, as a rule, either too fragmentary or too indistinct as to decoration to be of interest archæologically. If all the shell (and, incidentally, all the copper) objects which were found in crumbling remnants at Moundville, could be represented entire in this memoir, we are confident an important page would be added to the history of prehistoric art in America.

In small fragments, on the second investigation, were found what remained of two shell drinking-cups which evidently had been covered with incised decoration.

Another shell drinking-cup, decorated with straight lines over part of the surface, lay in contact with the skull of an extended skeleton.

Several undecorated drinking-cups also were found.

In addition to several gorgets, of which only traces remained, we got from the ground south of Mound D a gorget (Fig. 94) lying between the skulls of an infant and of an adult at full length on the back, which were almost in contact. The decoration of the gorget, which we believe to be a very highly conventionalized serpent design—the rattles and eyes, and possibly a fang, being, we think, distinguishable—is shown in Fig. 95.

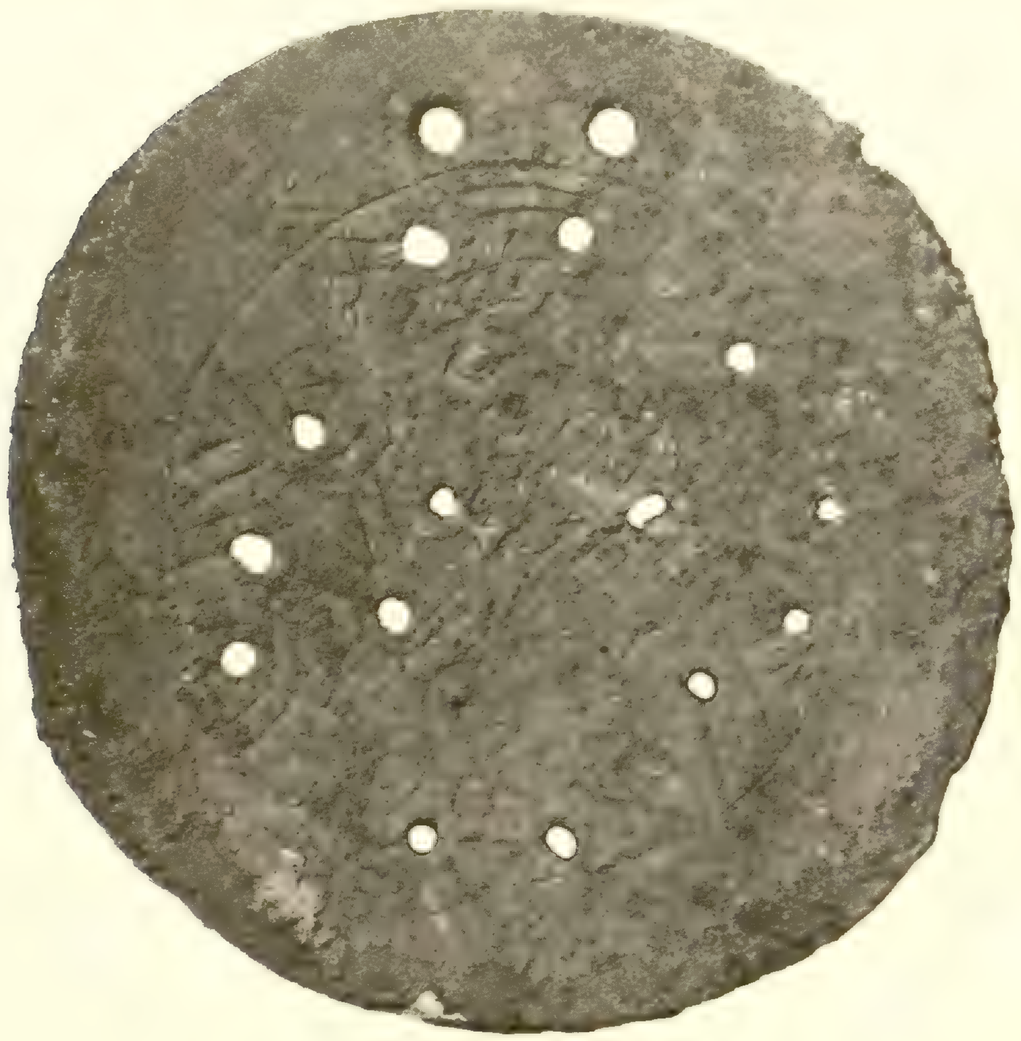


FIG. 94.—Shell gorget. (Full size.)

A fragmentary gorget of shell is of interest in that upon it stand two birds facing each other with a shrub or bush between. This same design was found by us on a shell gorget from a mound on the Alabama river,[1] above the city of Montgomery, and is found at the present day among the Huichol Indians,[2] descendants of ancient Mexicans.

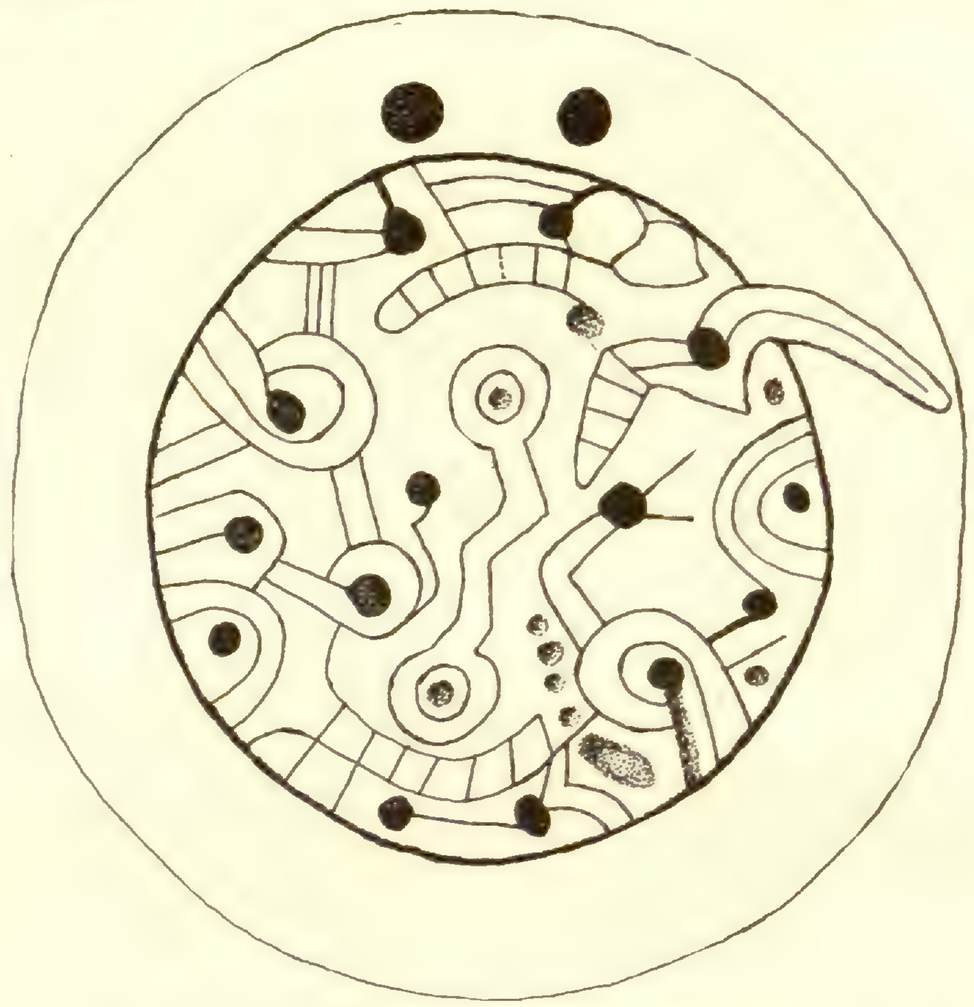


FIG. 95.—Shell gorget. Decoration showing highly conventionalized serpent design. (Full size.)

With respect to shell objects, in one instance alone were we fortunate. Burial No. 98, the skeleton of an adult extended on the back, had on one side of the head a bowl and on the other side a water-bottle. On the breast, protected by a bone, which had got in position above it, was a superb gorget (Figs. 96, 97) with incised decoration represent-

[1] "Certain Aboriginal Remains of the Alabama River," Fig. 55. Journ. Acad. Nat. Sci. of Phila., Vol. XI.

[2] Dr. Carl Lumholtz, "Decorative Art of the Huichol Indians," Figs. 436 and 437. Am. Mus. Nat. Hist. Memoirs. Vol. III.

FIG. 96.—Gorget of shell. (Full size.)

FIG. 97.—Gorget of shell. Decoration, perhaps the man-eagle. (Full size.)

ing perhaps the man-eagle,[1] the serrated marking on the neck seemingly indicating the eagle.

At the time of our first visit to Moundville, we found a shell gorget which is referred to in our report (page 172). This gorget was so thickly covered with patina that the details of the decoration upon it were not distinguishable. Considerable work was done with a view to the removal of the coating, but satisfactory results were not obtained.

FIG. 98.—Decoration on shell gorget. (Full size.)

Since the publication of the report, however, much attention has been given to this gorget, and we are now able to reproduce the greater part of the design (Fig. 98). This design, the lines of which exceed in delicacy those upon any shell gorget ever found by us, represents a figure, the head of which, unfortunately, is in part indistinguishable. The series of squares above the head is no doubt part of a head-dress, though its connection with the head is not traceable. Other details also are too indistinct to be included in the drawing.

This gorget evidently belongs to the same class as that of some from the Mississippi Valley, the claw-hands calling to mind the claw-feet of the fighting figures on the shell gorget from Tennessee shown by Holmes.[2]

With many burials were shell beads (with nineteen in the ground south of Mound D), some globular, almost one inch in diameter; some very minute. There were also small spool-shaped beads and tubular ones; and, in one instance, perforated, flat, pentagonal, and hexagonal sections of shell. With these beads in several instances were pearls perforated for stringing.

A beautiful little pendant of shell, to which we have already referred in describing the so-called "hoe-shaped" implements of stone, is in the form of a ceremonial axe with the ring at the end of the handle, for suspension (Fig. 99).

FIG. 99.—Pendant of shell representing ceremonial axe. (Full size.)

Several hair-pins of shell, as well as a number of objects resembling hair-pins but shorter and more rounded at the point, were encountered.

A small spool-shaped object of shell went to pieces after dis-

[1] See "Eagle." "Handbook of American Indians."
[2] W. H. Holmes. Rept. Bur. Amer. Ethn. 1880–81, Plate LXXIV.

covery; and a shell ornament resembling two globes fastened together, one somewhat smaller than the other was found.

With a burial was a mussel-shell (*Unio forbesianus*) showing wear at one end.

The skeleton of an adult, lying at full length on the back, had the skull resting in a bowl—an accidental position, not an urn-burial. In the bowl were several pebbles and a shell (*Dosinia discus*), perforated for suspension.

Apart from human remains in the ground south of Mound D, was a mass of mussel-shells, some single, some in pairs, among which were *Tritigonia tuberculata*, *Unio crassidens*, *Quadrula cornuta*, *Q. pustulosa*, *Q. pyramidata*.

With a burial were fragments apparently of a gorget, resembling calcite, which, however, proved upon microscopic examination to be *Finna* shell.

COPPER OBJECTS.

In our first investigation at Moundville, with the exception of one copper fish-hook, and a few fragments of sheet-copper lying in one place, no copper was found by us except in cemeteries on certain of the mounds, where many ceremonial axes of copper and ornaments of sheet-copper were unearthed. We know the followers of De Soto saw chiefs dwelling on mounds, with their people living around them on the level ground below. It is reasonable to suppose that the principal men were buried on the mounds and that these men were more richly endowed with objects of value than were their followers who were buried on the plain. However, on our second investigation, which was confined practically to the flat country around the mounds, while no artifacts of solid copper were found, we were fortunate enough to obtain some objects of sheet-copper and of wood copper-coated.

On the face of Burial Number 164, a full-length skeleton lying on the back, in the ground south of Mound D, was a most interesting pendant of sheet-copper, one side of which is shown in half-tone reproduction in Fig. 100; and a drawing of the other side, after we had ventured on additional cleaning, is represented in Fig. 101.

FIG. 100. — Pendant of sheet-copper, with Burial No. 164. One side. (Full size.)

The upper part of the pendant has parts excised to form a six-pointed star within a circle. On the body of the star, *repoussé*, is a symbol to which we shall revert later. Below is an excised triangle; beneath

which is part of an arm encircled by a string of beads and an extended hand bearing on it the open eye, all *repoussé*.

The symbol to which we have referred has been described by us in our first report[1] on Moundville, and by others, as the open eye. Subsequent discoveries have modified our views.

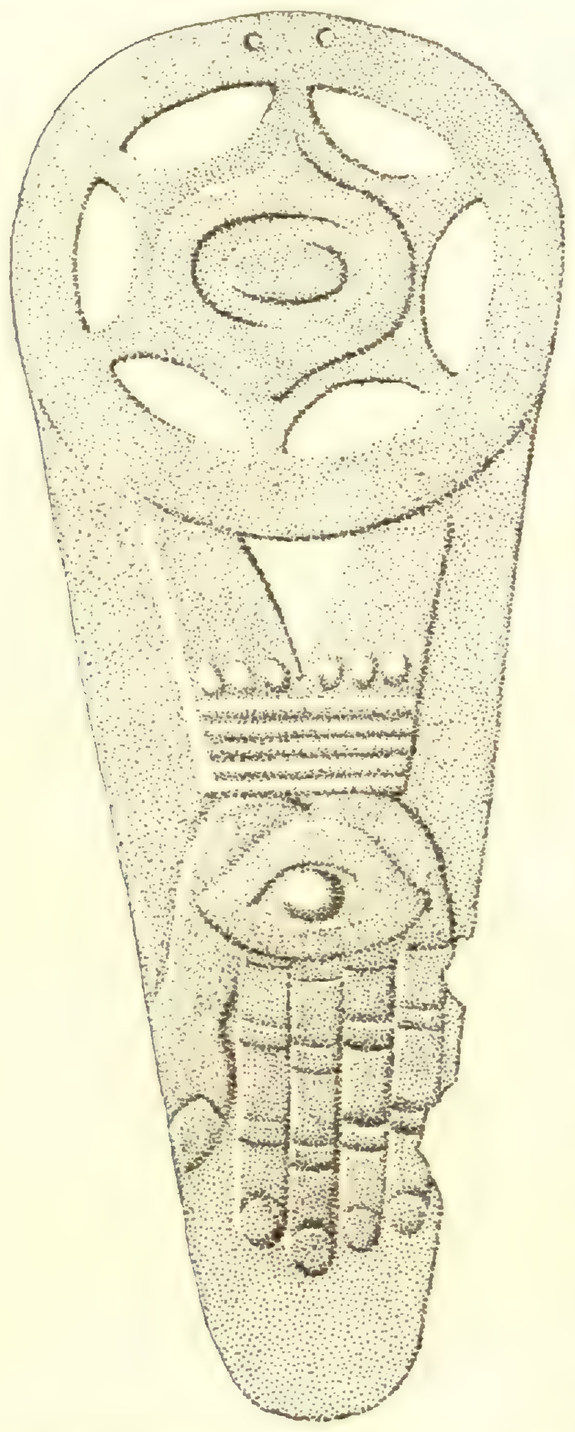


FIG. 101.—Pendant of sheet-copper, with Burial No. 164. Other side. (Full size.)

On our second investigation at Moundville, we found two water-bottles bearing the same symbol incised as a form of decoration (Figs. 41, 42). It also figures on the copper pendant we are describing and on a vessel (Figs. 37, 38) where it appears in a modified form beneath the tail of a woodpecker —a singular position for an eye.

On the hand which figures on the gorget is the unmistakable Moundville eye, found at that place on many occasions. It seems unlikely that different forms of the eye should be shown on the same gorget.

Furthermore, the symbol in question is always[2] represented with the angles in a vertical line, while the eye most familiar to the pottery, copper, and stone of Moundville, as well as the human eye which it represents, have the extremities in a horizontal line.

On the whole, whatever the symbol under discussion may stand for, it seems doubtful that it is a representation of the human eye.

In contact with the temporal bones of Burial Number 40 (the adult burial with the infant already described), probably three on each side, were pendants of sheet-copper, some in fragments. These pendants, which bear no decoration, resemble in form the arrowhead-shaped pendants, each stamped with an eye and other markings, found by us at Moundville on our first visit, and figured in our first report. We described these pendants as representing arrowheads, but we are now inclined to believe that they are bird-head pendants. These particular ones perhaps represent the head of the woodpecker.

Pendants of the same type, but somewhat dissimilar in detail, were found by us in mounds of the Alabama River above and below Montgomery. One of these pendants, however, we believe represents the head of a quadruped—teeth being indicated.

[1] Fig. 102, page 195 ; Fig. 121, page 209.

[2] The copper gorget shown in our first report being too thickly coated with carbonate to permit of finding the holes for suspension, and thus to learn where the top of the gorget was, was arbitrarily placed in the photograph.

The reason for our change of opinion in regard to these pendants is that certain markings are present, which in the Moundville specimens seem to indicate the bill of a bird. Also the presence of the eye seems to point more to an animal than to an arrowhead; although, for that matter, there is no reason why an aborigine should not have placed an eye upon an arrowhead with the same intention as the Chinese have when painting it upon their boats.

A number of other bird-head pendants of sheet-copper, in fragments, some decorated with the eye, some not, were found at our second investigation.

We obtained also, with various burials, six entire, or almost entire, sheet-copper pendants, elongated-oval in outline, each having excised and *repoussé* decoration, including the swastika within a circle, and the triangle. These pendants, ranging between 6.1 inches and 2.6 inches in length, resemble in type some figured in our former report; one (Fig. 102) lay at the neck of an infant

FIG. 102.—Pendant of sheet-copper, with Burial No. 148. (Full size.)

(Burial Number 148), with a few shell beads.

FIG. 103.—Sheet-copper pendant showing *repoussé* swastika. (Full size.)

FIG. 104.—Pendant of sheet-copper, with pearl attached. (Full size.)

Another pendant (Fig. 103) lay near the skull of Burial Number 65, a badly decayed skeleton of an adult, at full length on the back, in a grave cut into the solid clay of the base, in the ground south of Mound D. With the pendant, which has a *repoussé* swastika (all the others found having this cross through excision), was a small cuboidal mass of galena (lead sulphide).

Still another pendant (Fig. 104) lay near the skull of Burial Number 132, an aboriginal disturbance. This pendant has a large, perforated pearl, through which

vegetable fiber passes, attaching it on the outer side of the pendant over the two holes for suspension. Several other copper pendants found by us in fragments had pearls fastened in a similar way.

Burial Number 162, the skeleton of an adult, at full length on the back, from the ground south of Mound D, had shell beads at the shoulder and on the pelvis, encased in wood (as the copper found by us ordinarily is), a fine, large, sheet-copper pendant below the chin, the broad end uppermost. Under the chin and over the right clavicle was an elliptical gorget of sheet-copper (Fig. 105) having a pearl fastened to it in the manner already described.

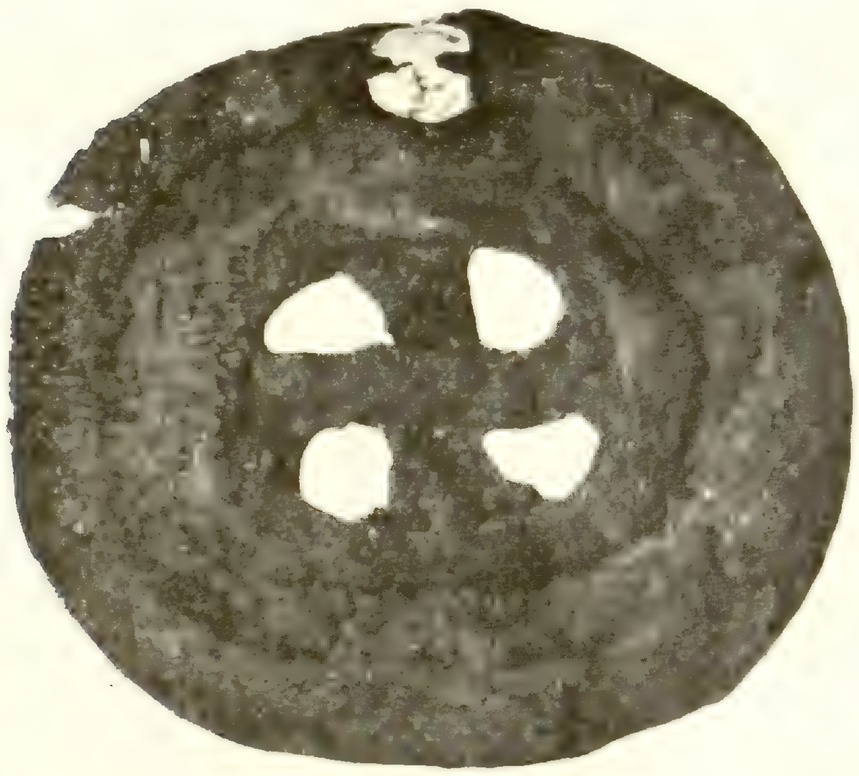


FIG. 105.—Gorget of sheet-copper showing swastika, with pearl attached. (Full size.)

With an aboriginal disturbance were two sheet-copper discs, each about 1.25 inches in diameter, and each having a boss centrally perforated. These discs lay at the feet, the bone of one great toe being green by contact. With them was a mass of red paint, determined chemically to be hematite, and the knuckle-bone of a deer. These discs, which somewhat resemble those shown by LeMoyne as worn on the legs of Florida Indians, were, however, probably ear-plugs transferred from their original position by an aboriginal disturbance.

Burial Number 34, a skeleton of an adult, fully extended on the back, had shell beads on both wrists. At each side of the head was a disc of wood, about 1.5 inches in diameter, with central boss, copper-coated. On the copper had been a covering of wood or bark, a part of which, badly decayed, still remains. Extending from the middle of the under side of each disc is a pin of bone, which, no doubt, worn through the lobe of the ear, connected the disc in front with another of some perishable material behind the lobe (Fig. 106).

FIG. 106.—Ear-plug of wood and sheet-copper, with bone connection. (Full size.)

Two pairs of discs, with pins, similar to those above described, were found—each pair with a burial.

One wooden disc, copper-coated, two inches in diameter—probably an ear-plug—lay with Burial Number 9 in the field near Mound M.

A most interesting object, probably a rattle, made of wood overlaid with copper, unfortunately fell into small fragments on removal.

This object, which had undergone injury, probably through disturbance in early times, had one end missing. Seemingly it had been intended to represent the shell of a turtle. The width was 4.75 inches. Within was a cavity 1.6 inches by 2.25 inches, containing many small pebbles. Nearby were parts of various small objects of thin wood, copper-coated, too fragmentary for identification; also several pearls pierced for stringing and a representation of the regular Moundville eye, wrought from shell, which apparently had been inset—presumably in the rattle.

Another copper-coated rattle in small fragments (identified by the presence of pebbles) was found later in the investigation.

Fragments of sheet-copper found with various burials will not be particularly noted.

ASSOCIATED OBJECTS.

We shall now describe a few selected burials in order to convey some idea of the association of objects at Moundville.

Burial Number 20, the skeleton of an adult, extended on the back, in the field west of Mound R, had on the thorax, inverted over another vessel, a bowl with the head and the tail of a fish represented on opposite sides. The lower vessel, a bowl with a decoration of incised, encircling lines, lay on its side. A head, which formerly projected from this bowl, is absent through breakage in aboriginal times, the thrifty savages having been quick to utilize for the dead what was no longer desirable for the living. Under this bowl was a bone piercing implement. Immediately beneath the head of the skeleton, with which these vessels were, was the bottom of what had been a vessel of coarse, heavy ware.

In a pit in the same field as the foregoing lay three skeletons of adults. One at full length, face down, had a pot at the left shoulder. With the other two—one extended on the back, the other partly flexed on the right side—was nothing in immediate association.

Lying together in the pit, apart from the burials, were a vessel in many fragments; a fragment of sheet-copper; a ceremonial palette of fine-grained stone, 7.5 inches in diameter, with marginal notches, and incised circles on one side; part of a smoking-pipe of coarse sandstone, to which reference has been made; and an incisor of a large rodent, kindly identified by Prof. F. A. Lucas as the left lower incisor of a beaver (*Castor canadensis carolinensis*).

Burial Number 9, in the field near Mound M, an adult extended on the back, had near the knees a water-bottle. Four small, neatly-made arrowheads of chert, and a number of small fragments of the same material, to all of which reference has been made, were near by. Along the right leg were masses of hematite in a condition to use as paint. Above, and about one foot from the pelvis was a water-bottle. Shell beads were at the left wrist. Between the left elbow and the ribs were a small discoidal stone and a disc of sheet-copper. Near the head were sheet-copper pendants in fragments. In contact with the skull was the curious object of earthenware shown in Fig. 22, which at first seemed to us to have been made from

the base of a vessel, but which proved to be not the case. At the back of the skull was a bone pin, round in cross-section, about 7 inches long; and bits of sheet-copper. Nearby was another pin about the same length, stained with copper and having bits of sheet-copper in association. These pins probably fitted into ornaments of sheet-copper intended for use in the hair, of the kind found by us in Mound H at our first visit to Moundville. About one foot from the skull was a pendant of sheet-copper.

Burial Number 44, in the field west of Mound R, a skeleton of an adult extended on the back, had a small "celt" at the right elbow. Small shell beads were at the neck. At each side of the head were sheet-copper ear-plugs with bone pins, which have been described by us elsewhere in this report. Along the humerus were seven piercing implements of bone. Although these implements lay parallel one to another, their points were not all in the same direction. With the bone implements lay two small stone "celts," one of which is double-bladed.

In the ground south of Mound D, 1 foot 8 inches from the surface (in the made ground), was a pot-shaped oven of clay, burned hard to a thickness of about one inch. The diameter of the oven was 1 foot 6 inches; its depth, 7 inches. In it lay a large part of a cooking pot, covered with soot.

It is our belief that Moundville was at one time an important religious center and that the great mounds within the circle (which are too large, we think, to have been merely domiciliary) were connected with the cults held sacred at that place.

Prominent among these cults, presumably, was the worship of the sun. We know from Charlevoix, from du Pratz, and from Chevalier Tonti, that the worship of the sun still obtained in their time in regions not remote from Moundville, and that the divinity had temples and priests, and that sacred fire perpetually burnt as an emblem of the sun.

According to Tonti, the sun was the deity most commonly adored throughout all that region.

To the eastward of Moundville, in earlier times, the cacique Vitachuco told the Spaniards under DeSoto that they were "sons of the devil and not of the sun and moon, our gods;"[1] and in the Moundville region itself a follower of Tuscaloosa at Mauvila spoke of the sun and moon as deities.[2]

If then, Moundville was a religious center and heliotry was prominent among its cults, we would naturally expect the engraved designs on the earthenware to bear witness to the fact, since religion so often finds expression in the art of primitive peoples.

Let us consider the designs found on both our visits to Moundville,—the plumed or horned serpent; the eagle; the woodpecker; the six world-"quarters;" etc.

[1] "*La Florida del Inca.*" Garcilaso de la Vega (Madrid, 1722) Second Book, First Part, Chapter XXI, p. 54.

[2] *Ibid.* Book Third. Chapter XXVI. Page 149.

If we find these to be connected with sun-worship elsewhere, it is likely they had a similar significance at Moundville.

Among the Hopi,[1] back of sun-worship, we generally detect sky-god worship—the sun being only a symbol, mask, or shield, not the god of the sky or distinct from the sky-god.

The great horned or plumed serpent is a sky-god, sometimes referred to as a sun-god, the sun being a symbol of certain attributes of the sky-god.

Near the Hopi pueblo of Walpi, the spring Tawapa, supposed to be the home of the plumed serpent, is called the sun-spring.

The horned or plumed serpent cult, as a form of sun- and sky-worship, was widely distributed in ancient Mexico, as well as among the early inhabitants of the Mississippi valley. The plumed serpent and symbols probably representing the sun, appear together on a bottle made by the mound builders of Arkansas.[2]

In ancient Mexico Quauhtli, the eagle, was sacred to the sun. The sun himself was often called "the rising eagle" instead of his more common name, Tonahtiuh, "the lord of day."

We are indebted to Miss H. Newell Wardle, of the Academy of Natural Sciences, for various references including that which Charlevoix makes to two figures of eagles on the roof of the sun-temple in the Louisiana-Mississippi region, and which Tonti describes as "a couple of spread-eagles which looked towards the Sun."

Eagles' feathers are used with discs to represent the sun-god among the Hopi of Arizona (Fewkes). Among the Huichol Indians, descendants of ancient Mexicans, "young Mother Eagle" is intimately connected with the cult of the sun, and according to one account, is his mother.[3] Among the same Indians, the giant woodpecker (first cousin to our ivory-bill of Moundville) is sacred to the sun.[4]

We have given elsewhere in this report our reasons for supposing it a possibility that the six world-"quarters" of ancient Mexico, and of the present Mexican and Pueblo Indians, were known to Moundville and figured on its vases.

If such is the case we can connect these directions with sun-worship among the Hopi, where the priest makes offering to the six world-"quarters," of feathered strings, some of which are tied to an emblem representing the sun (Fewkes).

In our first report on Moundville we show on a vessel (Figs. 87, 88) haloed or winged suns, each crossed by an arrow, perhaps emblematic of the sun's rays, and possibly indicating the cult of the sun.

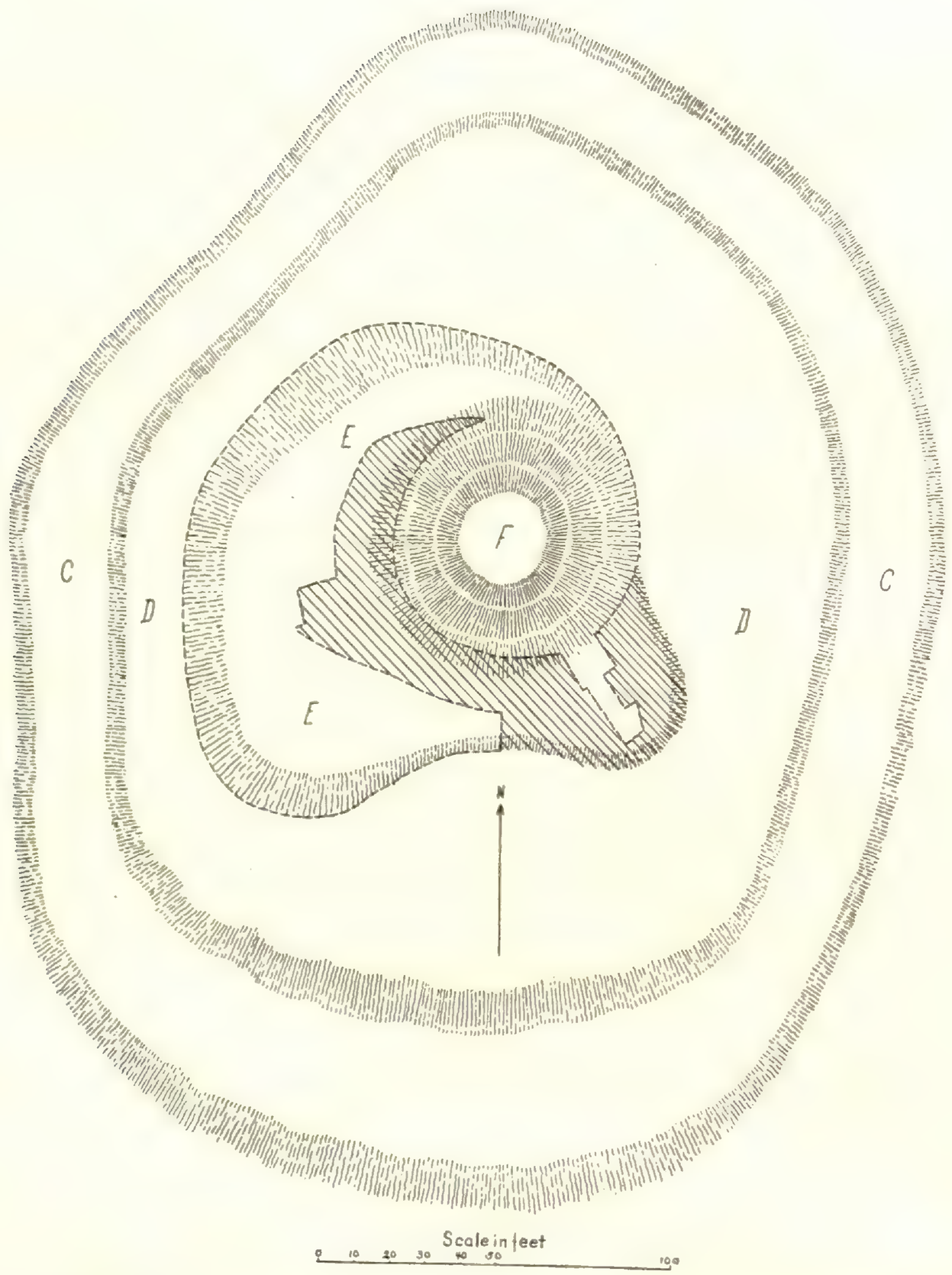
At all events, whatever opinion we may form in regard to the cults of prehistoric Moundville—an opinion which must be based largely on conjecture—we know the region to have been a most interesting one and the inhabitants of Moundville to have figured among the foremost in the art of the ancient peoples of what is now the United States.

[1] "Hopi Shrines near the East Mesa, Arizona." Amer. Anthropologist, April-June, 1906. Dr. J. Walter Fewkes—and in private letters.

[2] W. H. Holmes. 20th An. Rep. Bur. Amer. Ethn., p. 91.

[3] Dr. Carl Lumholtz. "Symbolism of the Huichol Indians," p. 14, Mem. Am. Mus. Nat. Hist Vol. III.

[4] Dr. Carl Lumholtz. *Ibid.*, p. 11.



Place of burial, Crystal River. Portion dug at first visit, enclosed in broken line; at second visit, shown by diagonal lines.

CRYSTAL RIVER REVISITED.

By Clarence B. Moore.

Crystal River, on the western coast of Florida, about twenty-five miles south of Cedar Keys, was visited by us in the season of 1903. Considerable work with interesting results was done there near the well-known, rectangular shell-mound about three miles from the river's mouth. Full account of this work is given in our "Certain Aboriginal Mounds of the Central Florida West Coast."[1]

By consulting the accompanying plan it will be noted that the scene of our investigation was an enclosure surrounded by an embankment, and that the enclosure consisted of first a level space, then much ground sloping upward and, finally, a well-defined mound rising above this slope.

At our first visit, though we dug away the entire mound and a large portion of the sloping ground, we left a part of the latter uninvestigated. Therefore we revisited the place of burial near Crystal River in the winter of 1906, with the kind consent of Mr. R. J. Knight, of the town of Crystal River, the owner of the property, to whom we were indebted for permission to investigate before.

The plan given herewith shows the embankment (C C); the level ground inside the embankment (D D); the slope (E E); and the mound proper (F). The area excavated by us at our first visit, with the exception of small portions around a few trees, is shown enclosed in broken line, while the part dug through at the time of our second visit appears in diagonal lines.

This second investigation, as the plan shows, included all the sloping ground that remained, consequently the entire slope and the mound proper have been dug down by us. The maximum diameters of the area investigated are 150 feet northeast to southwest and the same distance from northwest to southeast.

The digging was begun on the margin of the slope and was carried in at a depth considerably below the surface of the surrounding level ground. The height of the mound proper above the general level was 10 feet 8 inches, and above the elevated ground which surrounded it, it was from 5 feet 8 inches to 6 feet 8 inches.

Burials, almost invariably consisting of skeletons, were found by us at our second visit to lie as a rule under deposits of shell as we found them before. These deposits of shell did not extend to the surface, but lay under the superficial sand; and the deposits were not over single burials as a rule, but were layers covering a number of burials. In the southern and southeastern part of the elevated ground a layer of shell was almost continuous, and skeletons lay here and there beneath it. A few skeletons were found in sand apart from shell, but these were met with at the border of the mound proper, and probably belonged to the mound. When digging down this mound at our first visit we found that its con-

[1] Journ. Acad. Nat. Sci. of Phila., Vol. XII.

struction differed from the sloping ground around it in that deposits of shell were much less numerous in the mound, and consequently many burials were in clear sand apart from shell.

Bunched burials, only a few of which were found at our second visit, invariably lay in sand, and were always at a less depth than the shell deposits beneath which other forms of burial lay. However, these bunched burials were found where the mound joined the sloping ground and probably were left over from the great number of bunched burials which we found in the mound proper at the time of our first visit.

There were also in the sand and in the shell layers numbers of scattered and broken human bones. It was impossible for us to classify these as to form of burial and no account of them is taken in our enumeration.

During the second visit 186 burials were met with, as follows:

Full length on back, of which 27 were children,	115
Full length, face down,	1
Closely flexed on the right side,	9
Closely flexed on the left side,	8
Partly flexed on the right side, including 4 children,	18
Partly flexed on the left side, 2 being children,	17
Partly flexed on the back, knees up,	2
In caved sand,	5
Details omitted from field-notes, a child,	1
Infant skeleton badly decayed,	1
Bunched burial with one skull,	1
Bunched burials with two skulls,	2
Bunched burials with three skulls,	2
Bunched burial with seven skulls,	1

The three remaining burials, somewhat differing from the general types, will be particularly described:

(1) Adult, trunk on back, thighs turned upward and outward at an obtuse angle, legs flexed back at an acute angle, feet crossed.

(2) Adult, full length on back, legs crossed at knees.

(3) In a pit below the base, badly decayed skeletons of two infants, together.

Throughout the second investigation but two skulls[1] in a preservable condition were found. No skulls or parts of skulls showed evidence of cranial compression.

With a number of burials was sand tinted by admixture of red hematite, and a few burials lay with sand made yellow by the addition of powdered limonite.

The artifacts found during our second investigation are practically of the same character as those found by us before, though the experience of our former visit was emphasized, namely, that objects of superior quality had been placed in the mound proper and not in the elevated area which surrounded it. On this, the second visit, when our work was of necessity confined to the sloping ground, but

[1] The Academy of Natural Sciences catalogue numbers 2231, 2232.

one earthenware vessel of superior ware and decoration was found, and this came from where the slope joined the mound proper and really belonged to the mound. Objects of crystal and of amethystine quartz, unbroken pipes, and copper (if we exclude a single object found in sand thrown out from the mound in our former visit) were not encountered on this occasion, though the yield of such objects was abundant at the time of our first investigation.

Artifacts, as before, were found with some burials and also scattered in sand and in the layers of shell. Possibly the scattered objects had belonged to burials represented by the disordered bones of which we have spoken; indeed it is likely that some of them did. We are inclined to believe that in some cases, also, artifacts

FIG. 1.—Sherds. Crystal River.

were placed in the shell layers collectively for the dead in common. At all events, on one occasion at least, a deposit of sand colored with hematite occurred in a layer of shell in connection with artifacts, and this deposit of colored sand was compact as if intentionally placed in the shells and not scattered as seemingly it must have been had it been an accidental accompaniment of disarranged bones.

Fragments of earthenware found during our second visit were inferior or were of medium excellence in the main, giving little evidence of what we know the

aborigines of Crystal River could accomplish in the potter's art. The small check-stamp is represented, as is the complicated stamp to a limited extent. A selection of sherds, recovered during our second visit is shown in Figs. 1, 2.

One fragment of earthenware is of much interest. At our former visit we were fortunate enough to find in the mound proper a part of what had been a large,

FIG. 2.—Sherds. Crystal River.

cylindrical vessel of excellent ware. This fragment, which bears an incised and boldly executed design representing an open hand, and small parts of other interesting symbols, is shown in Fig. 18 of our former report, in which we set forth how we searched without avail for other parts of this vessel.

We were fortunate enough to find, this time, in sand tossed out on our former visit, another fragment which undoubtedly belonged to the same remarkable vessel. The ware is the same; the curvature is identical; and the decoration, in our opinion, is from the same bold hand that executed the design on the fragment first found by us. Unfortunately the two fragments do not join, though both belong to the upper part of the vessel and include parts of the rim. We have, altogether, less than half the circumference of the upper six inches of a vessel originally about five inches in diameter. The original height of the vessel cannot be determined, though judging from parts of the decoration which are missing, the height must have been considerably in excess of that of the fragments found by us. The fragment last found is shown in Fig. 3.

FIG. 3.—Fragment of vessel. Crystal River. (About full size.)

Professor Holmes writes that the figures on these two fragments "are probably parts of a single design, or at least a group of related designs, which covered the entire exterior surface of the vessel. They are, indeed, interesting, as you suggest, and illustrate the versatile genius of the southern potter; but they are not generically distinct in character or execution from others. * * * *

"I do not see the least reason for attributing these figures to the whites or suspecting white influence. They are aboriginal in every way."

Two sherds belonging to a vessel of coarse, porous ware seem to have borne an interesting design where what may have been intended to represent the head of a bird, front view, appears in relief on the flaring neck of the vessel. At one side is seen an incised design perhaps showing part of a wing.

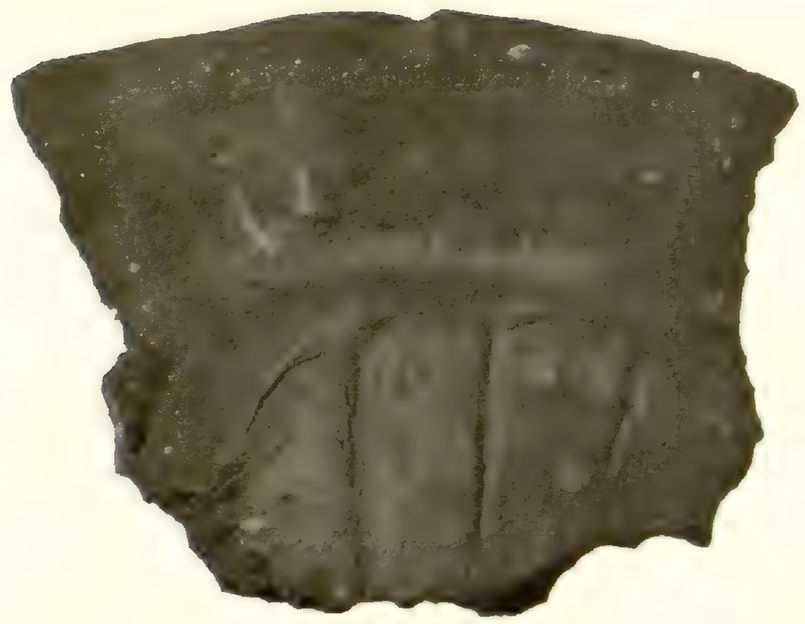


FIG. 4.—Fragments of vessel. Crystal River. (About full size.)

River gave distinct evidence of contact with Europeans, and as we have found vessels with feet in many other mounds, the contents of which gave no proof of the influence of white men, we believe that aboriginal vessels with feet were not of necessity inspired by contact with Europeans.

We shall now describe in detail the vessels of earthenware found by us during our second visit, continuing the enumeration from the last number in our former report.

On the second sherd is probably part of another wing which, however, by no means corresponds with the first one (Fig. 4).

A small fragment of a vessel, found in this investigation (Fig. 5 and diagram, Fig. 6) seems, judging from form and decoration, to have been the tail on a vessel representing a bird. If such is the case, the vessel was a marked exception, as the life-form, so abundant in the pottery of the northwestern coast of Florida, is conspicuously absent from the earthenware of the central western coast.

A fragment of a monitor-pipe of earthenware was found apart from human remains.

Among fragments of earthenware met with at this visit, as before, were a number of parts of vessels which had possessed four feet, and several entire vessels each having four feet also. As nothing found by us at either visit to the aboriginal place of burial at Crystal

FIG. 5.—Fragment of vessel. Crystal River. (About full size.)

Vessel No. 27.—This vessel, found in separate fragments, somewhat scattered, but since put together, is a small, undecorated bowl of excellent ware, having the rim projecting hoirzontally, as shown in Figs. 25 and 33 of our former report. The base has sustained the mortuary mutilation often practised in Florida and in parts of Georgia and of Alabama, to "kill" the pot that its soul might be free to accompany that of the departed.

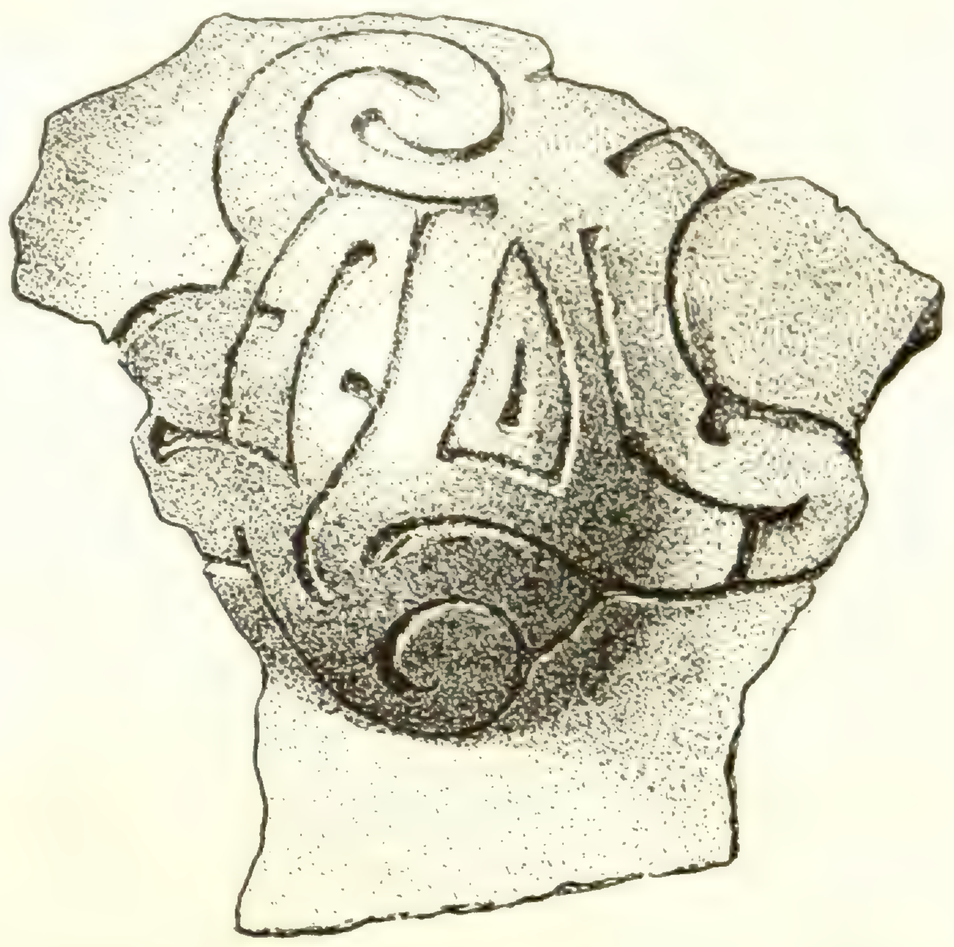


FIG. 6.—Fragment of vessel. Decoration. Crystal River. (Full size.)

Vessel No. 28.—This vase, which lay on the chest of the skeleton of a child, is a rudely-made, asymmetrical vessel of eccentric shape, having carelessly-made line decoration (Fig. 7). There are two perforations for suspension. A small, round perforation is in the base. Carefully placed on this hole was a neatly-made disc of earthenware which was distinctly not that portion of the base that had been punched out in order to make the opening.

FIG. 7.—Vessel No. 28. Crystal River. (Height 5 inches.)

Vessel No. 29.—An undecorated, imperforate bowl of inferior ware, found at the head of a skeleton.

Vessel No. 30.—A rude, undecorated bowl, from a shell layer, having a small, round perforation cut through the base.

Vessel No. 31.—A diminutive, imperforate toy pot with four feet, found apart from human remains.

Vessel No. 32.—An undecorated, imperforate toy vessel,

constricted around the middle and having a hole for suspension on two opposite sides of the aperture (Fig. 8).

Vessel No. 33.—A small, undecorated, perforate bowl of coarse ware, found at the ankle of a skeleton.

FIG. 8.—Vessel No. 32. Crystal River. (About full size.)

Vessel No. 34.—A pot of coarse ware, undecorated save for notches at the margin, found near scattered human bones. The usual mortuary mutilation is present.

Vessel No. 35.—A graceful, oblate-spheroidal vessel of excellent ware (Fig. 9), with basal perforation, having a short, upright neck and scalloped rim projecting horizontally; found in caved sand. The interesting line and punctate designs, each of which appears four times on the vessel, are shown in diagram in Fig. 10.

Vessel No. 36.—A small, undecorated, imperforate pot with four feet.

Vessel No. 37.—A small, imperforate vessel having four lobes and rude line and punctate decoration,

FIG. 9.—Vessel No. 35. Crystal River. (Diameter 6.5 inches.)

with four feet (Fig. 11). A part, missing when the rest of the vessel was found, has been restored.

Throughout this second investigation we unearthed fifty-three drinking cups wrought from conch-shells (*Fulgur perversum*).[1] of which twenty-one are imperforate and thirty-three bear the mortuary mutilation of the base. This number of cups, however, by no means represents the total of such cups in the tract dug through by us, inasmuch as many, probably as many again as we have noted, were found badly decayed and broken into fragments. Five other drinking cups were made respectively from *Fasciolaria gigantea*, *Fasciolaria tulipa*, *Cassis cameo*, *Fulgur pyrum*, and *Fulgur carica*. The last shell is of extreme rarity on the western coast of Florida so far as our experience has gone.

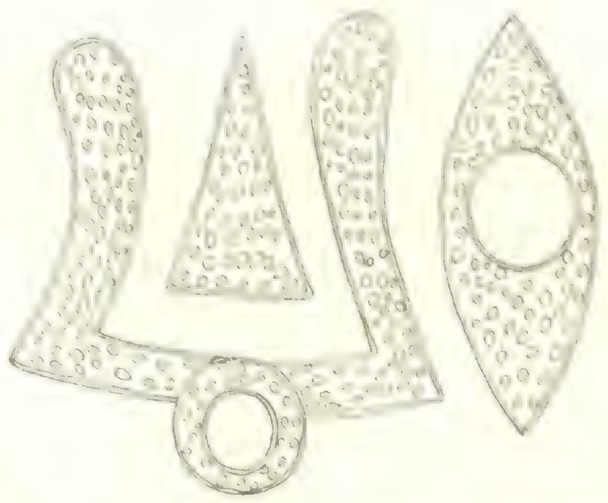


FIG. 10.—Vessel No. 35. Decoration. (Half size).

Thirty-three chisels and gouges, made from columellæ of large marine univalves, were found during our work. As we noticed before, these columellæ occasionally had a wing or flange left at the cutting edge to increase the gauge.

Seven gouges were met with, made from roughly triangular sections of the body whorl of *Fulgur perversum*. Several of these are unfinished, the grinding of the cutting edge apparently having been omitted.

FIG. 11.—Vessel No. 37. Crystal River. (About full size.)

There were found also seven "celts" fashioned from the thick lip of *Strombus gigas*. Most of these, as well as the majority of other objects of shell found during this investigation, were badly affected by lapse of time, some being covered with a thick coating of patina, which, peeling off in places, left them in a rather sorry condition.

During the digging were found: clam-shells showing wear; triangular sections of clam-shells; cockle-shells (*Cardium*) perforated for the reception of handles; a conch (*Fulgur perversum*) with two perforations for insertion of a handle at right-angles to the shell.

No fewer than forty gorgets of shell were found during our second visit to Crystal River, and had the aborigines who lived near the great shell-heap made use of engraved designs on these ornaments, as was sometimes the aboriginal custom elsewhere, the yield would have been interesting indeed. Unfortunately, most of the gorgets from Crystal River lacked decoration

[1] Dr. H. A. Pilsbry kindly has determined all shells referred to in this paper.

of any sort. The favorite form seems to have been a section of the body-whorl of a conch, sometimes including part of the shoulder, with one, two, or three perforations for suspension. Series of two and of three gorgets were found, usually with burials, and in one instance four gorgets lay together. Each series had gradation of size, the smaller lying within the larger. A few gorgets, wrought from considerable parts of body-whorls of *Fulgur*, somewhat resemble shallow drinking-cups, though the presence of small perforations for suspension places them in the gorget class. There are also circular gorgets variously perforated for suspension, some having large central holes in addition; and annular ones having a projection to which a cord could be attached. A few of the gorgets have on the convex side a series of concentric circles rudely executed—the only form of incised decoration met with on the gorgets at Crystal River. A selection of these gorgets is shown in Figs. 12, 13, 14, 15, 16.

FIG. 12.—Ornament of shell. Crystal River. (Full size.)

As in our former investigation, the yield of shell pendants on our second visit was large, seventy-two being found—in some cases a number with a single burial. All are of the same type as those found during our preceding visit, and all are grooved at one end for suspension. On many are traces of bitumen by the aid of which the cord or sinew had been attached.

Two oblong strips of body-whorls of *Fulgur perversum* were met with, each with a projection at one end for suspension, as shown in Figs. 17, 18.

In several instances small marine shells perforated for use as beads were found; and in one case a considerable number (*Marginella apicina*) lay with gorgets near scattered bones.

Where pendent ornaments were so much in vogue, one naturally would look

FIG. 13.—Ornament of shell. Crystal River. (Full size.)

FIG. 14.—Ornament of shell. Crystal River. (Full size.)

FIG. 15.—Ornament of shell. Crystal River. (Full size.)

for an ample yield of shell beads, since by strings of these such objects often were suspended. With three burials only did a few small beads of shell occur; these beads and four large shell beads, also with burials, were the sum total of our discovery in the way of ordinary beads of shell. At our first visit to Crystal River this dearth of beads was noted and commented on.

Shell hair-pins, as before, were conspicuously absent.

An object of shell of eccentric form and problematical use, found by us at the time of the second investigation, is shown in Fig. 19.

FIG. 16.—Ornament of shell. Crystal River. (Full size.)

On one edge are nicks or tally marks such as often are found on ceremonial objects.

Four small ornaments of shell, found lying together with a burial, are shown in Fig. 20.

A shell, a young *Fasciolaria gigantea*, ground smooth over its entire outer surface, has a round hole on one side for suspension.

During the second investigation were found in the sand and in the shell deposits the usual hammer-stones, hones, flakes of chert, parts of arrowheads or knives, and fragments of "celts." There were also two small balls of stone and half of a bar-amulet of slate.

FIG. 17.—Ornament of shell. Crystal River. (Full size.)

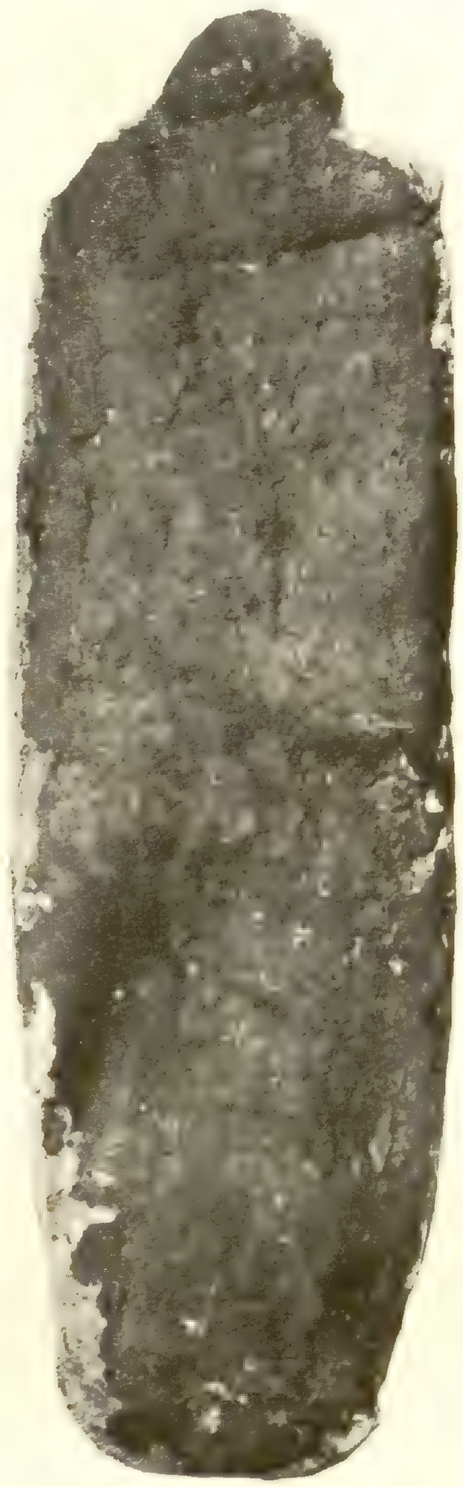


FIG. 18.—Ornament of shell. Crystal River. (Full size.)

Four "celts" were found, the largest having a length of 6.5 inches. These were presented to Mr. Knight, the owner of the property, without determination of the stone of which they are made.

Altogether, fifteen lanceheads, arrowheads, and knives were met with, some with burials and some apart from human remains. Five lanceheads, four of chert,

FIG. 20.—Ornaments of shell. Crystal River. (Full size.)

one of quartzite, lay with a skeleton. The remaining points—nearly all lanceheads—are of chert save one, an arrowhead of chalcedony. Several of the lanceheads, none of which exceeds 6.5 inches in length, are beautifully wrought, one of medium size being finely pointed and barbed.

With many burials were sheets of mica of irregular outline, some of them dyed red from contact with hematite. Other sheets, in abundance, lay apart from human remains.

A beautiful little ornament representing a turtle (Fig. 21), perforated for suspension, doubtless came from the neighborhood of a skeleton, though the ornament apparently lay alone. The material probably is catlinite. Various ornaments of this stone from Minnesota were found during the first investigation at Crystal River.

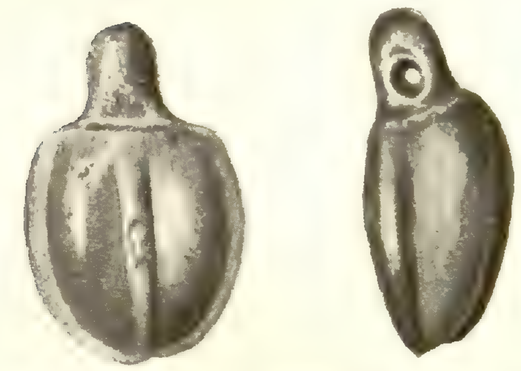


FIG. 21.—Pendant in form of turtle. Two positions. Crystal River. (Full size.)

FIG. 19.—Ornament of shell. Crystal River. (Full size.)

Seventy-three stone pendants or charm-stones were found during our second visit, some with burials, others apparently not directly associated with human remains. These pendants, which do not present any particularly new form, are mostly of the limestone and of the ferruginous limestone found near the Crystal River region, and one is of chert. One pendant is of calcite; one is of quartz, and a few are of other hard stones not found in

Florida. One of these pendants (Fig. 22) is almost a facsimile of the type of the two curious pendants of copper, each having two projections, found by us on our first visit to Crystal River and shown, one above the other, in Fig. 53 of our former report. A selection of four pendants found at the time of our second visit is shown in Figs. 23, 24, 25, 26.

In a deposit, together, were three pendants, probably of slate, of the same type as the long ones shown in Fig. 48 of our former report. Their lengths are 8.3 inches, 8.5 inches, 8.9 inches, respectively.

FIG. 22.—Pendant. Crystal River. (About full size.)

FIG. 23.—Pendant. Crystal River. (About full size.)

FIG. 24.—Pendant. Crystal River. (About full size.)

In Fig. 27 is shown a fossil shark's tooth which has been used as a pendant, as two encircling grooves, one at each corner of the root of the tooth, clearly prove. In a mound of the Georgia coast we found a fossil shark's tooth from which part of the root had been cut on two sides to facilitate hafting. The end ot this tooth was splintered by use.

FIG. 25.—Pendant. Crystal River. (About full size.)

FIG. 26.—Pendant. Crystal River. (About full size.)

FIG. 27.—Fossil shark's tooth used as a pendant. Crystal River. (Full size.)

Several masses of coral, hemispherical in shape, lay in the sand or in the shell layer, the flat surface of each mass showing marks of use as a smoothing-stone.

In sand thrown out at the time of the former investigation was part of an ear-ornament of sheet-copper, of the form sometimes designated "spool-shaped." The under portion of the ornament is somewhat defective by reason of former breakage; the upper part is entire.

On the upper surface of this upper part is a thin sheet of material resembling iron rust. That this material was not deposited after the ornament was placed in the mound (and we know that bog-iron sometimes is deposited in this way) is shown by two facts: The material does not lie over the entire ornament, but is symmetrically placed on the upper, outer surface, just as silver plating has been found upon similar aboriginal ornaments; and, secondly, an even covering of decayed wood is still present above the material. Evidently an even deposit of bog-iron would not form on one part of an ornament alone, and especially below a portion protected by a covering of wood. Therefore the plating was artificial.

As the ores of iron are not malleable and, therefore afford no material from which a coating of the kind found by us could have been directly made, the original plating must have been of metallic iron.

Small fragments of this coating, analyzed by Dr. H. F. Keller, proved it to be hydrated oxide of iron, containing nickel. This hydrated oxide could well be a derivative of metallic iron which had rusted through and through, and this hypothesis is strengthened by the fact that the material on the ornament is magnetic, while hydrated oxide ores of iron are non-magnetic, as a rule.

As it is practically certain that at Crystal River we have to do with a pre-Columbian site, we must reckon with the fact that this sheet-iron was of aboriginal origin solely.

It was not in the power of the aborigines to recover the metal iron from iron ore, and terrestrial native iron is not found in various localities in masses as the native, metallic copper is found; consequently, it is necessary to explain how pre-Columbian aborigines in Florida became possessed of iron in its native, metallic form.

Fortunately this can be done with the aid of Prof. F. W. Putnam[1] and Dr. L. P. Kinnicutt,[2] who have shown that iron from the Turner group of mounds in Ohio is meteoric iron, containing a large percentage of nickel, and showing other distinctive features.

In the plating of our specimen, which is rusted through and through, and from which only minute fragments could be taken, exact determination of component parts could not be made, but Doctor Keller has noted the presence of nickel[3]

[1] Sixteenth Report, Peabody Museum, Cambridge, 1882.

[2] Seventeenth Report, Peabody Museum, Cambridge, 1883.

[3] Doctor Keller found but a small quantity of nickel in our specimen, while the amount of nickel in the Ohio nuggets is relatively large. The analysis of the iron from Ohio was confined to nuggets of metallic iron. Doctor Keller thinks much nickel must have washed from the thin plating of our specimen during the transformation from metallic iron into iron rust.

in it, and to our mind there remains no doubt that the plating on the ear-ornament found by us at Crystal River was originally meteoric iron (which is metallic) similar to that found in the Ohio mounds in small masses and as plating on copper ornaments.

Professor Putnam writes:

"I have read your notice of the finding of an ear-ornament overlaid or covered on the upper surface with meteoric iron, and I am much interested in this very decided proof of the close connection of the prehistoric peoples of Florida who buried their dead in earth mounds, with those of the Ohio Valley region. You have shown, by many other objects which you have found in the Florida mounds, that this connection is exemplified by the arts of the people, and that there was much in common between some of the peoples of Florida and Ohio. This use of meteoric iron in covering the characteristic ear-ornaments, which are so common in the ancient mounds of Ohio and have not to my knowledge been found in the burial places of the recent Indian tribes, is very strong evidence of the unity of the ancient culture of the two regions. In other Florida mounds you have found such ear-ornaments made of copper. * * * The fact that the ancient Floridians made these copper ornaments in the same manner as did the builders of the ancient earthworks of Ohio, and that both used meteoric iron for covering the outer surface, is most instructive in tracing the connection of these ancient peoples.

"Similarly covered ear-ornaments have been found in considerable number in the Ohio mounds. I first found them on the altar of the Great Mound of the Turner Group and afterward with skeletons under the Great Mound of the Liberty Group (afterward known as the Harness Group). While Mr. Moorehead was working under my direction for the World's Columbian Exposition he found a number of these ornaments in a mound of the Clark, or Hopewell Group.

"Not only have we these ear-ornaments made in part of meteoric iron, but, on the altar of the Turner Group, we found other ornaments made of meteoric iron, as well as pieces of meteorites, while in the Liberty and Clark Groups celts made of meteoric iron were also found.

"This shows that the ancient people must have found masses of meteoric iron which they treated by hammering as they did native copper and native silver; and the great interest of your discovery in the Florida mound is that the people who made that mound at Crystal River had either found a mass of meteoric iron which they utilized in the same manner as did the ancient earthwork builders of Ohio, or else this ear-ornament which you found must have been obtained from the latter.

"It is probable that the meteoric iron from the Turner Group was derived from two distinct meteorites, as there is a slight difference between two of the smaller masses. The larger mass from the altar is known in the catalogues of meteorites, as the *Andersonville* Prehistoric Meteorite (Andersonville being the township in Ohio where the Turner Group is located in the Little Miami Valley)."

The latest discovery of meteoric iron in a mound is that of Wm. C. Mills, M. Sc., in the Edwin Harness mound, Ohio.[1]

[1] "Explorations of the Edwin Harness Mound." Ohio Archæol. and Hist. Quarterly. Vol. XVI, Num. 2.

Seventy-eight pointed implements of bone, made, as a rule, from the cannon-bone of the deer, split longitudinally, were unearthed during our second visit. Some doubtless were used as piercing implements, while some with flatter points probably served in basketry. Two slender implements, round in cross-section, show various small grooves at one end, worn by attachment of thread or fine cord. Among the pointed implements of bone are a number of lancets from the tails of sting-rays (*Trygon*). These objects, with their keen points, are admirably suited for use as piercing implements for which doubtless they were employed. Excluded from our enumeration of implements of bone were very many decayed fragments which in the past, no doubt, belonged to entire implements.

With finished implements often were unfinished ones, cannon-bones split longitudinally but not pointed.

Part of a lower jaw, which Prof. F. A. Lucas kindly has identified as belonging to the Virginia deer (*Odocoileus virginianus*), had been smoothed somewhat at its lower surface; the foramen had been considerably enlarged and all that side of the jaw in front of the four back molars had been cut away.

In several instances knuckle-bones of deer lay piled together.

Variously associated were: turtle-shells; five vertebræ of an unidentified fish, found together; a vertebra which Professor Lucas considers probably to have belonged to a grampus (*Grampus griseus*).

Professor Lucas has identified certain bones from the Crystal River place of burial as follows: "The front of cranium of carnivore and jaws, are from the same animal, the short-faced dog something like a bull-terrier that seems to have been a favorite with the Indians of the south and southwest."

As full details of the association of all objects found during the second investigation would occupy undue space, certain selected examples only will be given.

A skeleton lying full length on the back had, near the proximal end of the right humerus, a shell pendant. Three marine shells (*Oliva literata*), perforated for use as beads, were at the right elbow.

Another skeleton, also at full length on the back, had, under the legs, sheets of mica; sand, some tinged with hematite, some with limonite. Below the skull were: more pink sand; a pendant of limestone; a slab of compact rock as to the identity of which there is considerable doubt; one shell pendant; one pendant of a hard stone not found in Florida; four rudely triangular gorgets made from the body-whorl of *Fulgur*, each with one hole for suspension,—the two smaller ornaments lying within the larger ones; a rude section of shell with a central semiperforation. Under the head of one femur was an annular gorget of shell with a projection for suspension and having incised concentric circles on the convex side.

Still another full-length skeleton had at the left forearm, in a small pile, six astragali of the deer and two shells (*Oliva literata*) perforated for suspension.

At the head of a skeleton partly flexed on the left side was a shell drinking-cup within a turtle-shell and a neatly-made shell pendant within another drinking-cup of shell.

Near the skull of the skeleton of a child, six or seven years of age, were one shell chisel and eight stone pendants.

With a full-length burial were: twenty-one pointed implements of bone, entire, and seventeen of the same material, some broken, some partly decayed; five lancets of the sting-ray (*Trygon*); a lot of marine shells (*Macrocallista gigantea*); a fragment of a columella of *Fulgur;* bits of stone; sand colored red with hematite and yellow with limonite; a number of astragali and phalanges, with part of a jawbone, of a deer. All this deposit lay above the legs and feet of the skeleton.

Near the skull of a skeleton at full length on the back were four lanceheads of chert and one of quartzite; also a mass of fossil wood about 4.5 inches long, square in cross section.

With certain disconnected bones in the shell layer was the skull of a child near which were two pendants, one of stone, the other of shell, the grooved ends toward the skull.

Near the skull of the skeleton of a child, lying full length on the back, were a pendant of shell and one of stone. The grooved end of one of these pendants lay toward the skull, while the corresponding end of the other was directed oppositely. Incidentally, we may say here that the exact position of pendants in relation to parts of the human skeleton was a matter carefully noted by us during our work at Crystal River. As a rule, when pendants were not ceremonial deposits apart from human remains, or were not scattered as a result of aboriginal disturbance but lay immediately associated with a skeleton, the grooved end of the pendant lay nearest the bones. Sometimes, however, the grooved end was directed outward. This variety of position, we think, readily can be accounted for by calling to mind that a suspended ornament hanging taut would have the grooved end, around which the cord was placed, directed toward the point of suspension; while, should the strain be removed, as would be the case were the skeleton placed in a recumbent position, the upper ends of some of the pendants could swing outward.

A skeleton lying at full length on its back had a shell drinking-cup near the pelvis, and under the right knee nine marine shells (*Macrocallista gigantea*), the valves tightly closed, and pierced for suspension at points below the muscular attachment.

A skeleton partly flexed on the left side had on the thorax eight chisels and gouges, three made from the axis of the conch and five from its body-whorl.

A skeleton at full length had near the skull one shell pendant and one of stone. Over the shoulder and at the pelvis were fragments of mica. A stone pendant lay below the shoulder. On the thorax was part of a lancehead of chert. Above the chest were two pointed implements of bone. At the right forearm was a mass of green material kindly identified by Dr. George P. Merrill, Head Curator of Geology, United States National Museum, as arenaceous clay colored by iron. Sand dyed with hematite lay at the feet of the skeleton.

A noteworthy fact to which reference has hitherto been made is that nearly all objects of the greatest interest found in the entire investigation came from the

mound proper. In fact, in comparison with the yield of the mound proper, nothing of marked interest came from the sloping area which surrounded it.

The mound itself, as we have said, differed in composition from the sloping ground in that the mound contained much less shell and to a large extent was made up of clear sand. This sand continued to the very base of the mound on the general level of the surrounding surface, so that it seems clear that the mound was built first, and later surrounded, as to its lower part, by the sloping ground.

We know that when the mound proper was built a better class of objects was placed with the dead. Either the possessions of those living at that earlier period were of a higher grade than those of the persons who later built the cemetery around the mound, or else the makers of the mound proper were endowed with a greater spirit of liberality than were those who came later.

Before leaving Crystal River, six trial-holes, some 4 feet by 4 feet, some 4 feet by 5 feet, were made in the southern part of the embankment marked C C on the plan. Two skeletons were found, and one small pendant of limestone was met with in sand thrown out from one of the excavations.

MAP OF PARTS OF THE CHATTAHOOCHEE AND FLINT RIVERS

Reduced from Government Survey

Scale in miles

0 1 2 3 4 5 10

1906

X indicates mound

MOUNDS OF THE LOWER CHATTAHOOCHEE AND LOWER FLINT RIVERS.

By Clarence B. Moore.

Chattahoochee river, having its source in northeastern Georgia, continues in a southwesterly direction until it reaches the middle of the western boundary of the State at Westpoint; thence, flowing in a southerly direction, it forms the boundary between parts of Georgia and of Alabama and, later, between parts of Georgia and of Florida, until its union with the Flint river when, as the Apalachicola river, it continues in a southerly direction to the Gulf of Mexico.

Flint river rises approximately in the central part of Georgia and keeps a southerly and southwesterly course to its junction with the Chattahoochee.

This report treats of the aboriginal remains of part of the Chattahoochee and of part of the Flint rivers, in each case our journey being northward from the junction of the two streams, at which point our investigation of a previous season had come to an end.[1]

The portion of the Chattahoochee covered by us (see map) lies between River Junction, Fla., and the city of Columbus, Ga., a distance of 161 miles by water; and that part of the Flint investigated extends from the Junction to Bainbridge, Ga., 28 miles up the stream,—in each case our work being continued practically to the end of navigation.

As in former years, two agents, one of whom is thoroughly familiar with mound investigation, were sent out in advance of us thoroughly to cover our field of work that the exact situation of mounds and the names of their owners might be known to us, previous to our coming, thus saving a great expenditure of time.

On the Chattahoochee the presence of burial mounds was noted by us as far up as Columbia, Ala., a distance of 48 miles by water. Thenceforward mounds of a domiciliary character only were met with, having near them, doubtless, cemeteries in level ground. These cemeteries, however, we failed to find, save in one instance.

It is interesting to note, in the burial mounds of the lower Chattahoochee, the continuance of certain customs which have been practised in the mounds of the northwestern Florida coast and of the Apalachicola river, namely, the ceremonial deposit of earthenware in the eastern part of the mound for the dead in common, the use of life-forms in earthenware, excisions in the body of vessels, and the mortuary perforation of the base.

As to the mounds of lower Flint river, so few were found by us that no definite conclusion can be reached.

All measurements of earthenware vessels herein given are approximate only, and reduction of size in the illustrations is linear.

[1] See "Certain Aboriginal Mounds of the Apalachicola River." Journ. Acad. Nat. Sci. of Phila., Vol. XII.

Dr. M. G. Miller, as during all our previous archæological investigations, had charge of the anatomical part of the work of the expedition herein described.

The warm thanks of the Academy are tendered those owners of mounds on the Chattahoochee and on the Flint who kindly placed their mounds at its disposal.

Mounds and Sites Investigated on Chattahoochee River.

Mound near Kemp's Landing, Jackson County, Florida.
Mound below Hare's Landing, Decatur County, Georgia.
Mound near Old Rambo Landing, Decatur County, Georgia.
Mound near Steammill Landing, Decatur County, Georgia.
Mound near Shoemake Landing, Early County, Georgia.
Mound near Fullmore's Upper Landing, Houston County, Alabama.
Mound below Columbia, Henry County, Alabama.
Mounds near Purcell's Landing, Henry County, Alabama (4).
Mound near Paulk's Landing, Early County, Georgia.
Mound near Howard's Landing, Early County, Georgia.
Mound near Colomokee Landing, Clay County, Georgia.
Mound at Fort Gaines, Clay County, Georgia.
Mounds near Starke's Clay Landing, Clay County, Georgia (2).
Mound near Georgetown, Quitman County, Georgia.
Mound above Eufaula, Barbour County, Alabama.
Mound near Upper Francis Landing, Barbour County, Alabama.
Mounds near Rood's Landing, Stewart County, Georgia (8).
Dwelling site near Hall's Upper Landing, Chattahoochee County, Georgia.
Mounds near Woolfolk's Landing, Chattahoochee County, Georgia (2).
Mound and cemetery at Abercrombie Landing, Russell County, Alabama.
Mound at Mound Landing, Muscogee County, Georgia.

Mounds and Sites Investigated on Flint River.

Mound near Log Landing, Decatur County, Georgia.
Mound near Munnerlyn's Landing, Decatur County, Georgia.
Mound near Kerr's Landing, Decatur County, Georgia.
Burial-place on the Chason Plantation, Decatur County, Georgia.

MOUNDS AND SITES INVESTIGATED ON CHATTAHOOCHEE RIVER.

Mound near Kemp's Landing, Jackson County, Fla.

The mound, in high swamp, dry at low stages of the river, on property of Mr. M. A. Warren of DeFuniak Springs, Fla., lay about one mile in a SSE. direction from the landing. Its height was about 4.5 feet; its basal diameter, 33 feet. A broad trench had been dug in from the western side through the center of the

mound, previous to our visit, leaving, however, the eastern part intact. What was left of the mound was leveled by us.

Human remains found were confined to a small fragment of a skull.

Almost at the eastern margin, and extending to the northeast, began the usual ceremonial deposit of earthenware, put in for the dead in common, such as we have fully described in our reports on the mounds of the northwestern Florida coast and of the Apalachicola river. This particular deposit presented no new features. It began with sherds and parts of vessels and continued inward a number of feet, the latter part of the deposit being made up of groups of two or three vessels placed together, at short distances apart. Owing to the nature of the mound, which was of clay, no vessel was recovered entire, though a number were represented by a full complement of parts. There was little variety of form, pots and bowls being met with exclusively. The ware is inferior. Gritty tempering is absent. Decoration, when present, consists of the small check-stamp; the complicated stamp, faintly impressed; very rude incised line decoration in two instances in sherds; in one case an incised decoration of wavy lines and punctate markings as shown in Fig. 1. The rim of this vessel, which has been slightly restored in places, is not even, but rises and is depressed in the manner of the decoration beneath.

FIG. 1.—Vessel of earthenware. Mound near Kemp's Landing. (Diameter 5.7 inches.)

All vessels from this mound are small or of medium size, and all, including those represented by fragments, so far as could be determined, had undergone the mortuary perforation of the base so well known in Florida and in parts of Georgia and of Alabama, which was supposed to "kill" the pot and thus free its soul to accompany the souls of those for whom the mound was built.

MOUND BELOW HARE'S LANDING, DECATUR COUNTY, GA.

This mound, in high swamp, about a mile and a half in a southeasterly direction from Hare's Landing, on property of the Stuart Lumber Company, of Brinson, Ga., had a height of 5 feet, a basal diameter of 48 feet.

The mound, seemingly intact, symmetrical, circular as to its base, was composed of sand in the outer parts and of sand with a considerable admixture of clay farther in. With the exception of a comparatively small portion of the outer western part, it was completely leveled by us.

Human bones, so badly decayed that at times minute fragments alone remained, were found in forty-three places, from 2 feet below the surface down to the base.

In several instances the bunched burial was indicated, as was the flexed form of burial—parts of one at least showing a close flexion of a skeleton lying on the back.

In a number of cases charcoal lay with the bones, as did occasional masses of phosphate rock. Similar masses lay here and there in the mound, not closely associated with burials, though possibly in some instances accompanying bones had disappeared through decay.

Two feet from the surface, well in from the margin but not occupying a central place in the mound, were the remains of what probably had been a flexed burial, below which was a thin layer of charcoal extending beyond at each end. Immediately above the bones, for the full length of the burial, were masses of phosphate rock. A similar mass lay beside the skull.

With the exception of several bits of earthenware, no artifacts accompanied the bones in this mound.

Separately in the soil were flakes and chips of chert; decayed fragments of conch-shells; several pebbles of fair size, one showing marks of use; a mass of galena (lead sulphide) about the size of a child's fist, showing facets on all sides but one, on which was a slight depression; mica in two places; two handsome "celts" of hard rock not found in Florida, the larger 12.25 inches in length.

In the eastern marginal part of the mound were, here and there, a few fragments of pottery together. Thirteen feet in, in the same line as the deposits of fragments, vessels or large parts of vessels, all badly crushed with but few exceptions, were encountered together in twos and threes. With these were occasional decayed fragments of shell drinking-cups.

FIG. 2.—Vessel No. 2. Mound below Hare's Landing. (Diameter 7.1 inches.)

These small deposits of vessels of shell and of earthenware continued almost to the center of the mound. The vessels of earthenware and large parts of vessels, nearly all of inferior ware, and all, so far as could be determined, having the usual basal perforation, numbered twenty-eight in the aggregate. The decoration consists variously of a uniform coat of red paint; incised work on several occasions; the small check-stamp; the complicated stamp faintly and carelessly impressed; punctate markings.

We shall describe in detail vessels showing any features of interest, omitting the great majority which consists of pots and bowls, either plain or bearing commonplace decoration.

Vessel No. 2.—A bowl with punctate decoration shown in Fig. 2.

Vessel No. 3.—This beautiful vase of eccentric form, graceful outline, and excellent ware, bears a coating of red paint (Fig. 3). In addition, there is a well-executed incised decoration shown diagrammatically in Fig. 4. This vessel has a double base—the body proper having one, and the extension below it having another. Both have the usual mortuary perforation.

FIG. 3.—Vessel No. 3. Mound below Hare's Landing. (Height 7.5 inches.)

Vessel No. 4.—An effigy vessel about 12 inches in height, showing the human form, found in many fragments, but since joined together. Unfortunately the nose is missing. The figure is carelessly made and is distinctly inferior to similar vessels from the northwestern Florida coast.

Vessel No. 6.—A vessel of yellow ware, with ovoid body (Fig. 5), bearing a rather carelessly made punctate and incised decoration shown in diagram, Fig. 6.

Vessel No. 7.—This interesting vessel (Fig. 7), belonging to the ceremonial mortuary class, with excisions in the body (a variety first made known by us in our reports of the mounds of the northwestern Florida coast and of the Apalachicola river), was found in fragments which have since been cemented together, with slight restoration involving no important part. The base is missing. The ware, porous and generally inferior, as is usually the case with vessels made expressly for interment with the dead, is decorated with red paint. On one side is a handle or decoration consisting of the head of a long-billed water-bird.

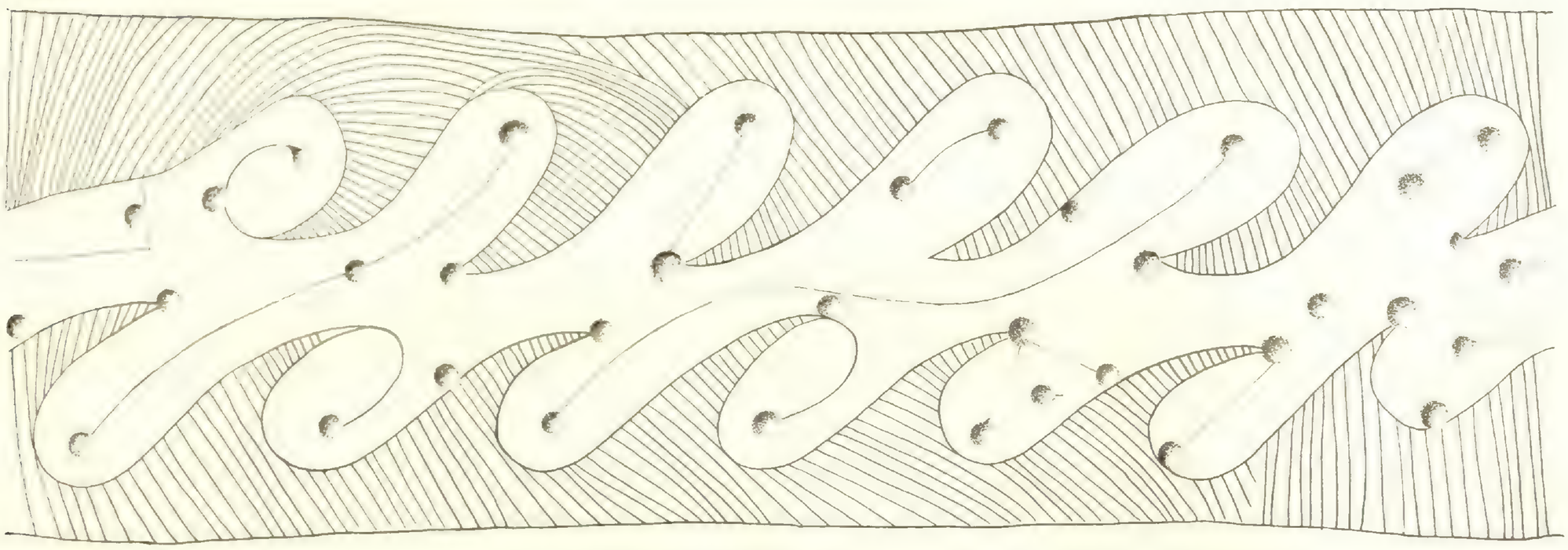


FIG. 4.—Vessel No. 3. Decoration. (About half size.)

The discovery of this type of vessel in this mound marks, we believe, its northernmost occurrence thus far reported.

FIG. 5.—Vessel No. 6. Mound below Hare's Landing. (Height 6.5 inches.)

Vessel No. 8.—Another ceremonial vessel, with open-work decoration, consisting in part of two excised leg-symbols on two opposite sides, bears a projecting head of a quadruped. There are traces of red pigment on the outer surface of this vessel (Fig. 8).

Vessel No. 9.—A ceremonial, mortuary vessel (Fig. 9) bearing slight traces of crimson pigment on the outside. Excised feather-symbols, upright and horizontal, surround the vessel, though no bird-head appears on the rim. A small part of this rim, not recovered by us with the rest of the vessel, may possibly be thought to have supported a plastic model of a bird's head, though we deem this most

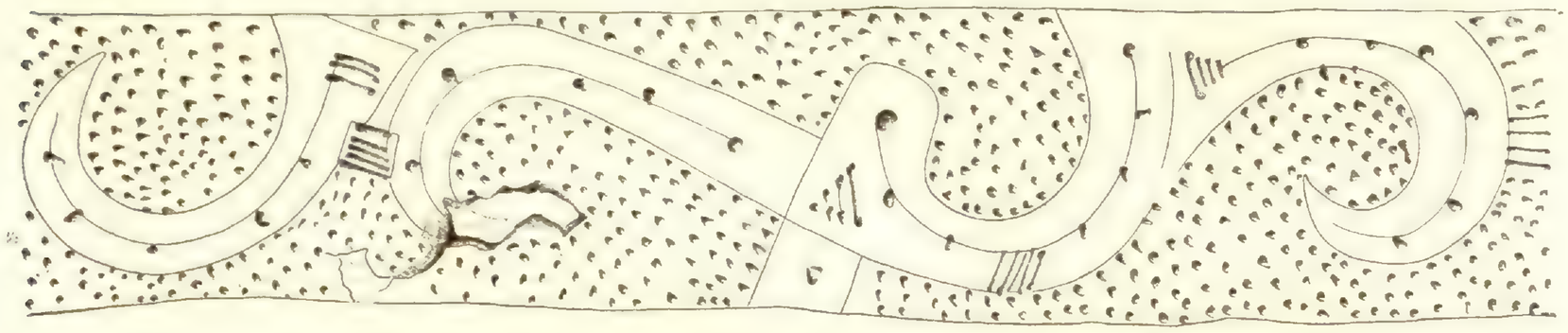


FIG. 6.—Vessel No. 6. Decoration. (About one-third size.)

FIG. 7.—Vessel No. 7. Mound below Hare's Landing. (Height 11.9 inches.)

unlikely, as the missing part of the rim is small, and surrounding parts show no thickening for the support of the head as almost certainly they would do had a head been present. Moreover, the feather-symbol (like others) is often used independently in decoration.

FIG. 8.—Vessel No. 8. Mound below Hare's Landing. (Height 10.4 inches.)

Vessel No. 10.—A graceful, mortuary vessel (Fig. 10) of the ceremonial class, with open-work decoration showing the feather-symbol, and having remnants of crimson paint on the outside. On one side of the opening the neck and head of a bird, from which the bill is missing, project upward.

The four ceremonial vessels from this mound, all of which were found in fragments, have in each case a hole knocked in the base and not made there previous to the firing of the clay, as is often the case with ceremonial vessels of this class.

FIG. 9.—Vessel No. 9. Mound below Hare's Landing. (Height 7 inches.)

Vessel No. 15.—Oblate-spheroidal in shape, found in fragments since joined together, having a low, upright rim. The decoration consists of a coating of red paint, inside and out.

Vessel No. 18.—This perforate vessel, shown in Fig. 11, of excellent yellow ware, has for decoration below the rim a band of punctate markings.

Vessel No. 27.—An imperforate vessel (Fig. 12) of good ware, found in fragments but since repaired. A deep depression around a central boss on each of the two longer sides is the only decoration. There are two perforations on one side slightly below the rim.

FIG. 10.—Vessel No. 10. Mound below Hare's Landing. (Height 13 inches.)

In one vessel from this mound was a small sheet of mica; in another was part of a cannon-bone of a deer.

Mound near Old Rambo Landing, Decatur County, Ga.

In a cultivated field on a plantation of Mr. J. L. Dickenson, of Donalsonville, Ga., is a mound about one-half mile in a NNE. direction from Old Rambo Landing. Correct measurements of this mound were difficult to obtain. Not only is the mound on a decided slope, but its lower parts at least have long been under cultivation and are much spread in consequence. A diameter of 65 feet for the roughly circular base, and a height of 6 feet for the mound are the approximate dimensions. There had been previous digging to a limited extent. Considerable inves-

Fig. 11.—Vessel No. 18. Mound below Hare's Landing. (Height 4.8 inches.)

Fig. 12.—Vessel No. 27. Mound below Hare's Landing. (Length 6.4 inches.)

tigation on our part indicated that the mound, which was of sandy clay, had been made for domiciliary purposes.

Mound near Steammill Landing, Decatur County, Ga.

Three-quarters of a mile below Steammill Landing, and about 100 yards from the bank, on another plantation belonging to Mr. Dickenson, is a low and much-spread mound of clay in a cultivated field. No success rewarded our digging in this mound.

Mound near Shoemake Landing, Early County, Ga.

In a cultivated field, belonging to the plantation of Mrs. Blanche Chancy, of Jakin, Ga., about one mile in a northerly direction from Shoemake Landing, was a mound about 2 feet high and 45 feet across its circular base, at the time of our visit. The mound, of sand, had been long plowed over, and probably considerably reduced in height. It had been dug into to a great extent previous to our visit,

including a trench across from west to east and a central excavation more than 15 feet in diameter.

While we were well aware that little but gleanings could await our search, we practically dug the mound through a second time, finding in some small, undisturbed parts a few fragments of decaying human bones.

Evidently there had been in the eastern part of the mound the customary ceremonial deposit made for the dead in common, inasmuch as many sherds, and large fragments of vessels which had been broken presumably by the previous digger, were found in disturbed sand. The ware, which ranges from ordinary to excellent, when decorated, bears: the small check-stamp; the complicated stamp, one variety being shown in Fig. 13; rude punctate decoration; incised parallel lines; incised decoration of complicated design, superior in every way.

FIG. 13.—Sherd. Mound near Shoemake Landing. (Half size.)

Lying on its side, so that previous digging had passed above it, was an interesting vessel about 11 inches in height, and with a maximum diameter of 8.3 inches, representing an owl (Figs. 14, 15). The head, incised and in relief, has the beak missing through former breakage. The wings are incised, as is the tail, on each side of which is the leg-symbol so well known on the western coast of Florida and elsewhere. The feathers are represented by punctate markings as hair sometimes is indicated in early Egyptian art.[1] The entire decoration on this interesting vessel is shown diagrammatically in Fig. 16. It has not been found possible to draw the decoration exactly to scale and to preserve the resemblance to the original at the same time; consequently the periphery of the field has been somewhat enlarged.

The base of this vessel has been knocked out, and many scattered fragments of earthenware from the mound indicated a mutilation of other vessels.

MOUND NEAR FULLMORE'S UPPER LANDING, HOUSTON COUNTY, ALA.

This mound, apparently untouched previous to our investigation, with the exception of a small hole in the center and a certain leveling due to recent cultivation, was in the southern end of a large corn-field, about a mile and a half in a SSW. direction from Fullmore's Upper Landing, on property of Mr. Coy Thompson, of Columbia, Ala.

The mound, which was completely demolished by us, had an average height

[1] Jean Capart, "Primitive Art in Egypt," Figs. 128, 129.

of about 3 feet, but being on the side of a natural slope its height varied decidedly according to the side whence the measurement was taken.

In a number of places in the mound were a few fragments of decaying human bones, but insufficient in form and quantity to indicate the character of burial. With

FIG. 14.—Vessel of earthenware. Mound near Shoemake Landing. (Height 11 inches.)

FIG. 15.—Vessel of earthenware. Side view. Mound near Shoemake Landing. (Height 11 inches.)

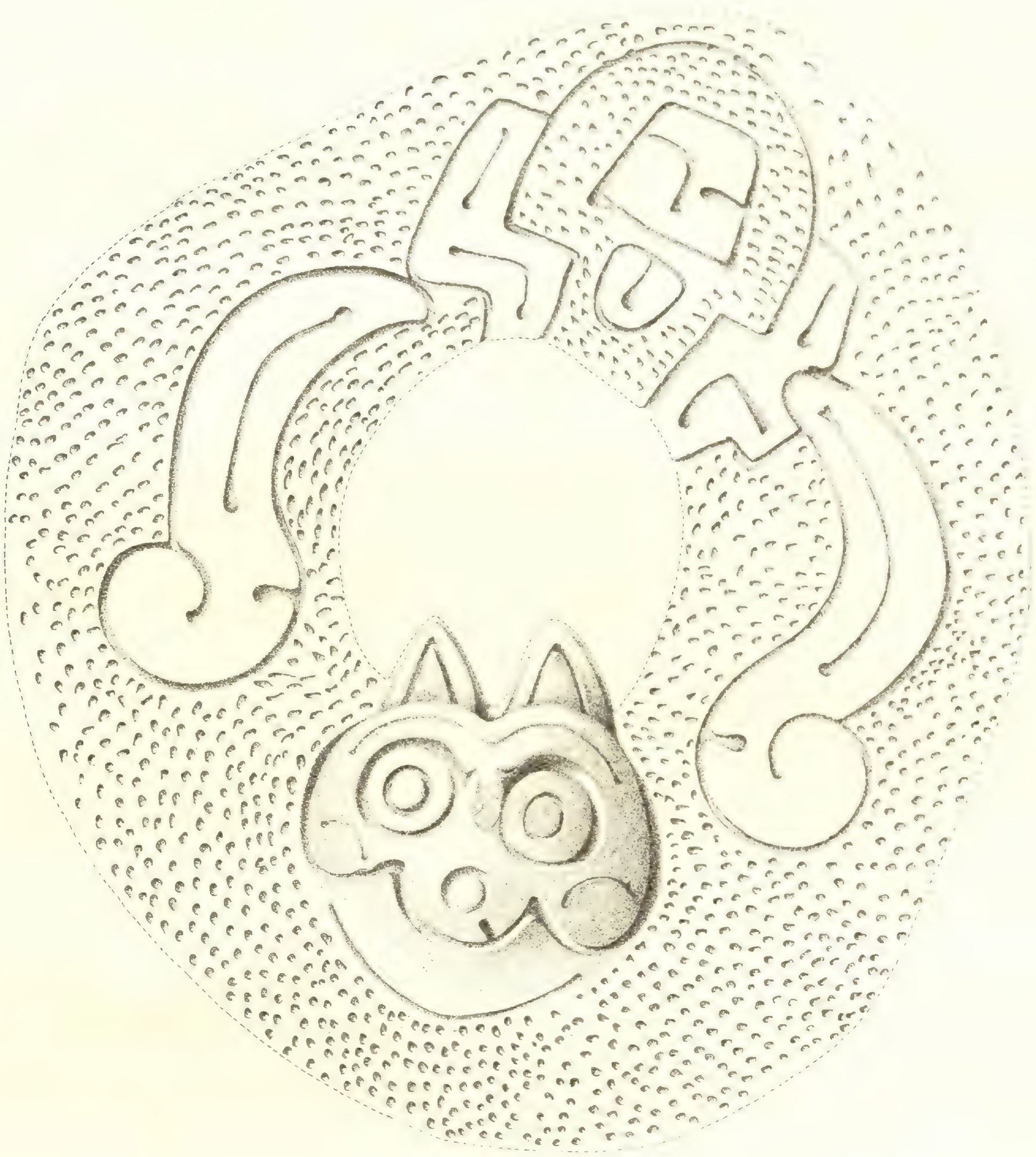


FIG. 16.—Decoration on vessel. Mound near Shoemake Landing. (About half size.)

the bones were fragments of decomposed chert,[1] some about the size of the human head, some somewhat larger, others smaller. The number of these masses with what had been a single burial ranged from one to four. Numerous other masses of this stone were present in the mound, perhaps marking places where burials had wholly decayed.

FIG. 17.—Vessel No. 1. Mound near Fullmore's Upper Landing. (Height 7.5 inches.)

Beginning at the eastern margin of the mound and continuing well toward the center, was the usual deposit of earthenware consisting of: scattered sherds; fragments of parts of vessels, placed together; vessels in fragments; considerable parts of vessels; and a few entire ones.

The decoration presented no new features. When the incised variety was present it was inferior to the best met with on the Chattahoochee.

Excluding the most ordinary types present in the mound, we shall describe the others in detail.

Vessel No. 1.—A vessel of compact, yellow ware with decoration of incised, encircling lines, cross-hatch, and punctate marking, shown in Fig. 17. A part of the vessel, missing through early breakage, has been restored.

Vessel No. 2.—A vessel of good, yellow ware (Fig. 18). The base, which is missing, was almost flat. The incised and punctate decoration is shown diagrammatically in Fig. 19.

Vessel No. 3.—Almost ovoid in shape, decorated inside and out with a uniform coating of red pigment. In addition, the upper part of the vessel

FIG. 18.—Vessel No. 2. Mound near Fullmore's Upper Landing. (Height 4.3 inches.)

[1] Kindly identified by Dr. George P. Merrill, Head Curator of Geology, United States National Museum, Washington, D. C.

bears evenly distributed, punctate markings. Parts of this vessel, missing when the rest were found, have been restored.

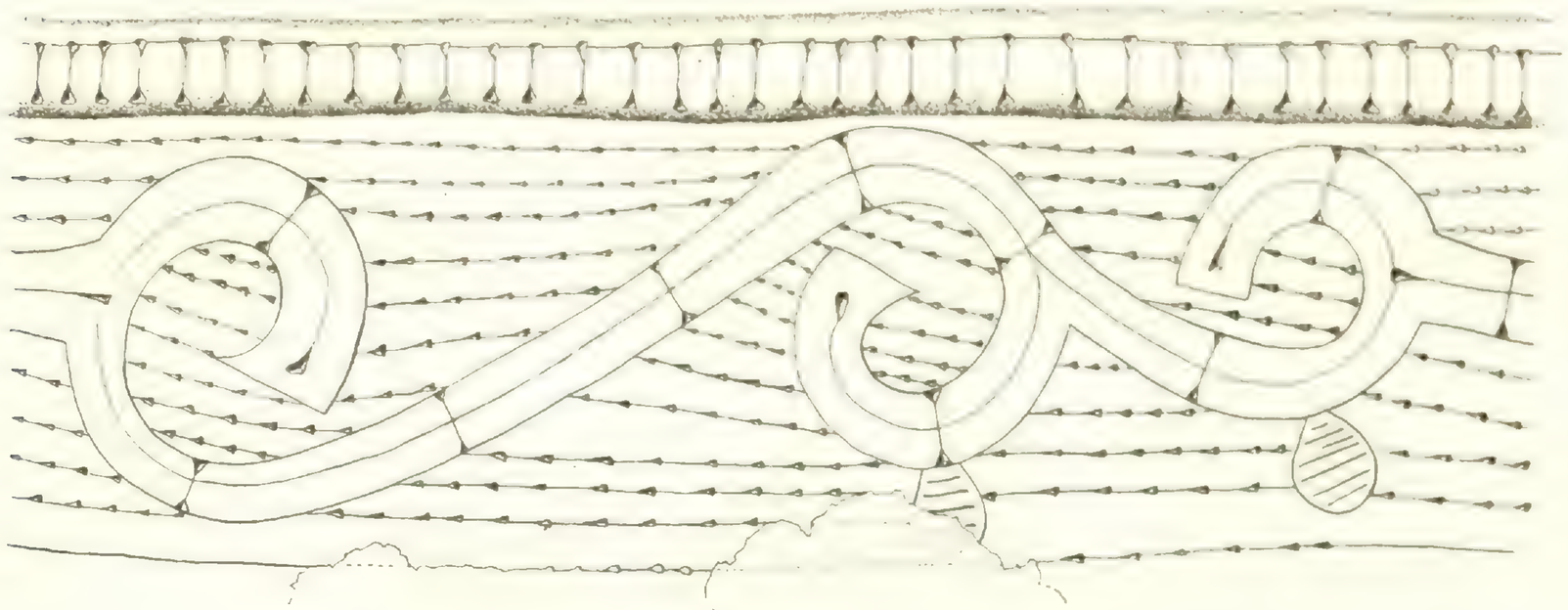


FIG. 19.—Vessel No. 2. Decoration. (About half size.)

Vessel No. 4.—A vessel of rather coarse, yellow ware, having a hemispherical body and a long, upright, cylindrical neck (Fig. 20), around which is an interesting incised and punctate decoration shown diagrammatically in Fig. 21.

Vessel No. 5.—An almost cylindrical vessel found in fragments, with certain parts missing. This vessel, which has been put together with some restoration (Fig. 22), bears an incised and punctate decoration with portions of the field covered with red pigment. This decoration, shown in diagram in Fig. 23, where the red is represented by stipple, is once repeated on the opposite side of the vessel.

Vessel No. 6.—A bowl of yellow ware, bearing incised decoration on a punctate field, the design being five times repeated (Fig. 24).

Vessel No. 7.—An imperforate vessel having five circular compartments, four being on one plane, the fifth rising above them centrally. The decoration consists of red

FIG. 20.—Vessel No. 4. Mound near Fullmore's Upper Landing. (Height 9.3 inches.)

pigment inside and out on the central compartment, and on the inside of the four lower compartments, which are smaller.

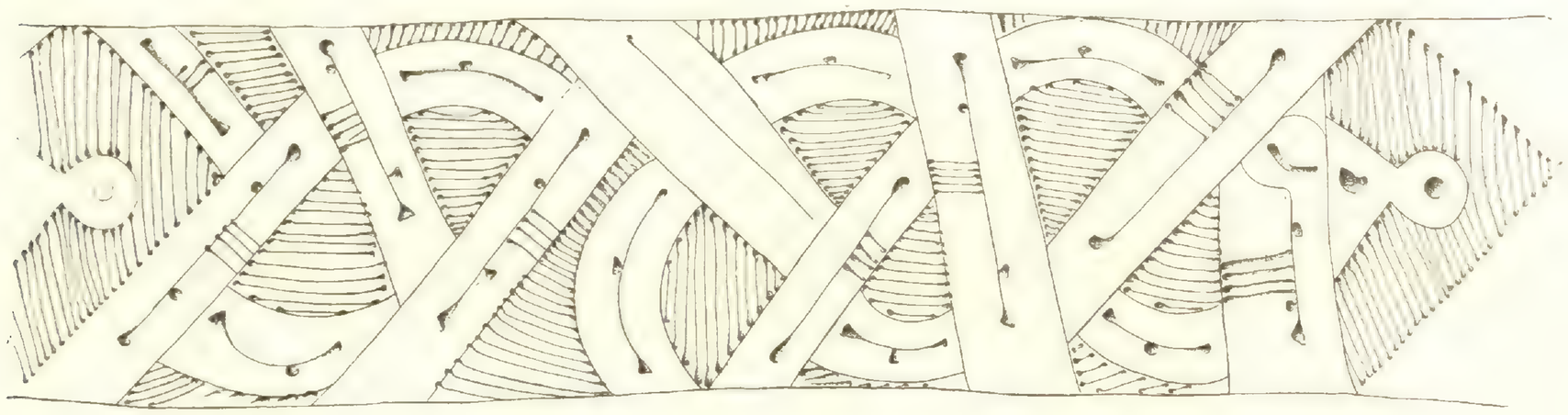


FIG. 21.—Vessel No. 4. Decoration. (About one-third size.)

FIG. 22.—Vessel No. 5. Mound near Fullmore's Upper Landing. (Height 10 inches.)

Vessels of this class, of course varying in detail, have been found by us in Florida along the northwestern coast from St. Andrews Bay to Cedar Keys; on lower St. Johns river; and on Apalachicola river. We have vainly sought to determine the use to which these vessels have been put. Their form might suggest receptacles for various pigments, but never have we found a deposit of paint remaining in a vessel of this class.[1]

All vessels in the mound, so far as noted, with the exception of the compartment vessel, had the usual mortuary perforation.

With the exception of the earthenware deposit, no artifacts were met with in the mound.

MOUND BELOW COLUMBIA, ALA.

On the same side of the river and in full view from the water, is a mound about a mile and a half below Columbia, on property of Mr. W. L. Crawford, of that place. The mound, evidently built for domiciliary purposes,

[1] Mr. F. W. Hodge, to whom we are indebted also for careful literary revision of these papers, has contributed the following note:

"The Pueblo Indians make and use such as condiment vessels. They generally have two compartments—one for salt and one for chile—but there are cups with several such compartments. Similar vessels are used of course for paints of different colors."

has a height of 8.5 feet above the level of the field behind it. On the river side it rises in line with the bluff. Its general symmetry has been somewhat impaired by wash of water in flood-time, though it still presents an impressive appearance. Its

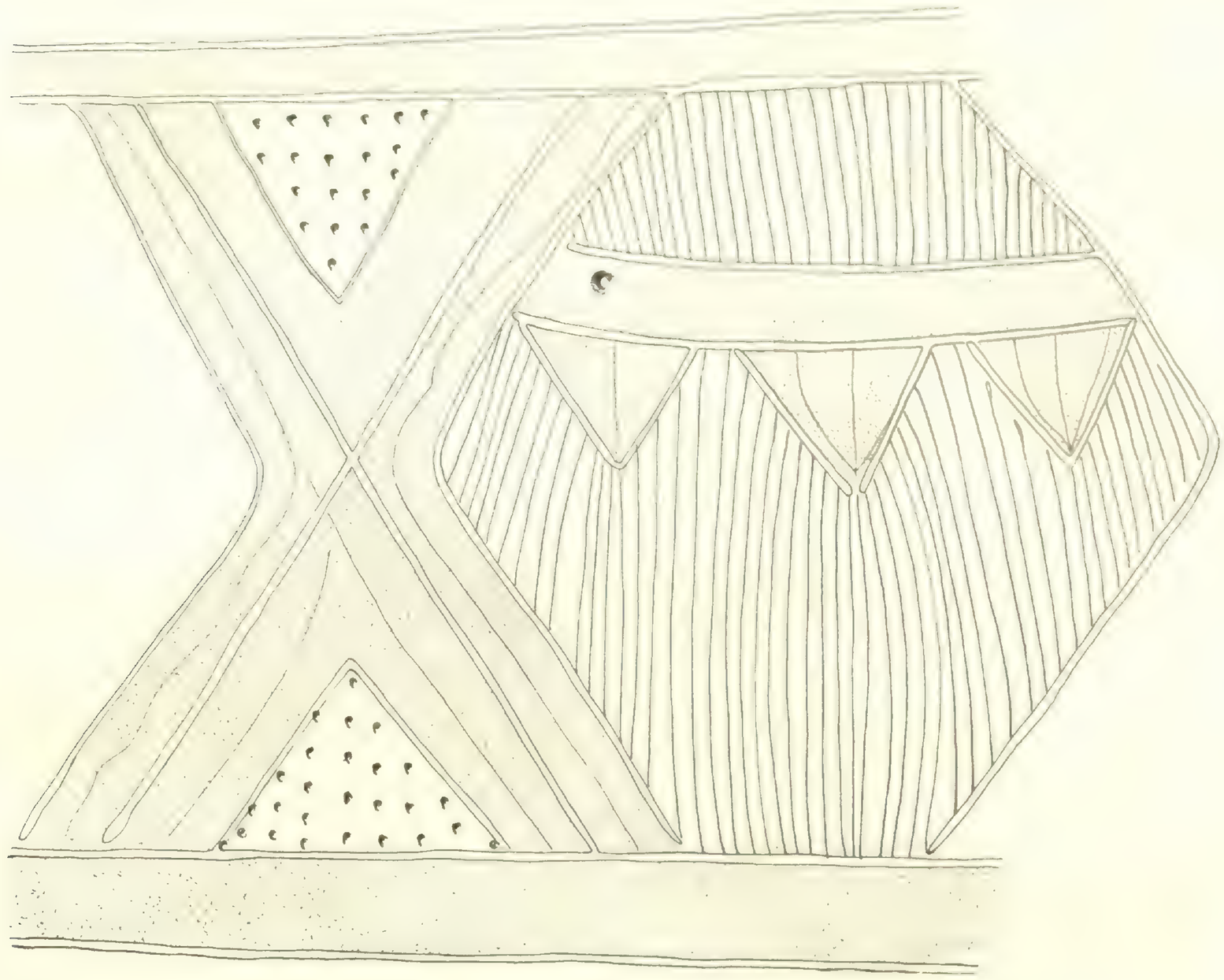


FIG. 23.—Vessel No. 5. Decoration. (About half size.)

length of base, N. by W. and S. by E., parallel with the river, is 138 feet. Its present width varies owing to wash of water in the past. Its base is 57 feet across at the northern end; 68 feet at the center; and 88 feet across the southern end. The summit plateau is 93 feet in length. Its width at the northern end, the middle, and the southern end, is, respectively, 23 feet, 34 feet, and 54 feet.

FIG. 24.—Vessel No. 6. Mound near Fullmore's Upper Landing. (Diameter 4.9 inches.)

As domiciliary mounds (of which class we judge this mound to have been) at times contain superficial burials, a number of trial-holes were dug in the summit plateau of this mound, with but negative results.

Mounds near Purcell's Landing, Henry County, Ala. (4).

On the river bank, about one-half mile N. by W. from Purcell's Landing, on the plantation of Mr. Harrison Purcell, of Columbia, on which also are the three mounds subsequently to be described, is a remnant of a mound, parts of the mound having been washed away in time of freshet. Considerable digging showed this remnant to be partly of clay and partly of sandy clay, in which were numerous masses of rock. No artifacts or bones were discovered.

About one mile westwardly from Purcell's Landing, in a corn-field, is what is left of a mound which has almost disappeared under cultivation. Trial-holes produced no material result.

In a field which has been under cultivation, but now lies fallow, about one-quarter mile NNE. from the preceding mound, is another, much spread by the plow in former times. Its present height is about 2 feet. Trial-holes gave only negative result.

In woods, about one-half mile eastwardly from the mound just described is a rise in the ground hardly distinguishable above the general level, which was mostly dug away by us. No bones were encountered, but in the eastern margin where, doubtless, a burial had been, were several large fragments of pottery and two bowls of moderate size, one having a decoration of red paint, the other, punctate marking below the rim. Each had the customary mortuary perforation of the base.

Mound near Paulk's Landing, Early County, Ga.

This mound was reported to us by our agent as being 200 yards from the river's bank and one-quarter mile in a NE. direction from the landing. The diameter was given as 80 feet; the height, as 5 feet.

The mound was not visited by us, as the owner put a high price on the privilege to dig it—a proceeding in marked contrast to that of most mound-owners with whom we have had to deal.

Mound near Howard's Landing, Early County, Ga.

This mound, in a cultivated field, about one-quarter mile NE. from Howard's Landing, seems to be largely of clay. Its height is about 3 feet; its basal diameter, 75 feet approximately. In appearance, the mound greatly resembles a class of flat, circular, domiciliary mounds found on the Chattahoochee river and elsewhere. We did not deem it worth our while to offer any inducement to the owner, who seemed to be courting a pecuniary offer before permitting investigation.

Mound near Colomokee Creek, Clay County, Ga.

This mound, on the river bank, about 150 yards above Colomokee creek, had been greatly spread by cultivation. Its height is about 4 feet; its diameter, about 80 feet. The mound, which had been courteously placed at our disposal by its owner, Mr. J. C. Neves, of Fort Gaines, Ga., had many trial-holes dug into it by us, showing it to be mainly of red clay, and apparently a former dwelling site.

Mound at Fort Gaines, Ga.

This mound, about 3.5 feet high and 90 feet across its circular base, is in the modern cemetery belonging to the town of Fort Gaines. Permission to dig it was granted us in a former season by Mr. J. Eugene Peterson, Acting Mayor of Fort Gaines, but the river at that time not being suitable for our steamer, our plans did not materialize. At the time of our visit, the permission given by Mr. Peterson was renewed by Mr. W. A. McAllister, Mayor of Fort Gaines, and by Mr. J. E. Paullin, President of the Cemetery Committee, all of whom expressed their willingness to permit the removal of a summer-house situated on the mound, should we find it necessary to do so.

A number of trial-holes, however, in many parts of the mound, showed it to be domiciliary in character.

Mounds near Stark's Clay Landing, Clay County, Ga. (2).

About one mile in an easterly direction from Stark's Clay Landing, in a cotton-field forming part of the plantation of Dr. J. T. Mandeville, of Fort Gaines, is a conical mound of sandy clay, the symmetry of which has been but little impaired by the spiral furrows left by cultivation. Rising from the level field, the mound, 126 feet in basal diameter and 18 feet in height, is a conspicuous object.

Previous to our visit a trench 12 feet wide, beginning part way up on the western side of the mound, had been carried in 23 feet, where it broadened into an oblong excavation 18 feet long by 15 feet wide. As much of the material had been thrown back by the diggers, the original depth of the trench could not be determined, but it must have been considerable.

Many trial-holes made by us, and considerable work in the former excavation, yielded neither bone nor artifact. No history was forthcoming as to any discovery made by former diggers. Presumably the mound was made for purposes other than that of burial.

A short quarter of a mile in a southeasterly direction from the mound just described is another, evidently domiciliary. This mound, on a slope, varies as to height. Probably 9.5 feet, the measurement as taken from the south, would be a fair average. The length of base is 230 feet, almost east and west; the width is 110 feet. The summit plateau is 146 feet by 74 feet. A number of trial-holes produced no material result.

Mound near Georgetown, Quitman County, Ga.

This mound, about a mile and a half in a southerly direction from Georgetown, in a cotton-field on the plantation of Mr. W. W. Green, of Gay, Fla., has been under cultivation for years and is greatly reduced in height. Its present altitude is 5 feet 4 inches; the diameter of its circular base, 100 feet. The surface is covered with camp-site debris, consisting of bits of pottery, flakes of chert, and the like. Although the mound had been long under cultivation, and, in addition, an upper portion had been carted away, it is said, we could learn from those in charge of no discovery of artifacts or bones. Trial-holes sunk by us were without result.

Mound above Eufaula, Barbour County, Ala.

About two miles above Eufaula, in view from the river, remains about half of what had been an oblong mound of red clay, with a flat summit plateau, the other part having been washed away during periods of high water. This mound, on property of Mr. H. Lampley, of Eufaula, was evidently domiciliary, as is indicated by its shape and by the negative result of a number of trial-holes dug by us.

Mound near Upper Francis Landing, Barbour County, Ala.

This mound, near the northern side of Williams Lake, about one-half mile from Upper Francis Landing, was visited by our agent in advance of our coming. Its height is reported to be 13 feet; its basal diameter, about 100 feet. The mound was not investigated by us as the owner refused permission, though much influence was brought to bear.

Mounds near Rood's Landing, Stewart County, Ga.

On the Rood plantation, about a mile and a half in from Rood's Landing, is a group of eight mounds, to some extent calling to mind the great earthworks at Moundville, Ala., though the mounds at Rood's Landing are much smaller, as a rule, and the circle around a central mound is incomplete, there being no mounds on the southern side, where a creek passes through the property.

These mounds, of the ordinary domiciliary variety, oblong, with summit plateaus, ranged between estimated heights of 7 feet and 20 feet, which latter is believed to be the altitude of the central mound.

Though the place has long been under cultivation, there is no history of the finding of artifacts, in which respect it greatly differs from the territory around Moundville, where for years objects of interest have been unearthed.

The owners of this plantation not only refused permission to dig even to the smallest extent, but practically declined to allow a survey, by prohibiting the cutting of branches of trees, without which proceeding lines could not be run; consequently we were unable to make an investigation of this interesting locality.

Dwelling Site near Hall's Upper Landing, Chattahoochee County, Ga.

About one-eighth of a mile in an easterly direction from Hall's Upper Landing, on the property of Mr. W. C. Bradley, of Columbus, Ga., is a large, cultivated field, thickly strewn with signs of aboriginal occupancy, including very many pebbles and parts of pebbles; occasional chips of chert; fragments of pottery of excellent ware, as a rule, but undecorated, with the exception of the use of green paint in one instance and of red pigment in another; bits of glass; many parts of clay trade-pipes made for barter with later Indians; part of what had been a well-made pipe of soapstone; strips of brass; a triangular object of sheet-brass, probably an arrowhead; a silver button, etc.

Although no doubt a cemetery is present in some part of this property, careful sounding with iron rods failed to locate it.

Mounds near Woolfolk's Landing, Chattahoochee County, Ga. (2).

About one mile ESE. from Woolfolk's Landing, on the plantation of Mr. B. T. Hatcher, of Fort Mitchell, Ala., are two small mounds closely associated, almost leveled by long-continued cultivation. Many trial-holes were without result.

Mound and Cemetery at Abercrombie Landing, Russell County, Ala.

About 50 yards from the river's bank, at Abercrombie Landing, on the plantation of Mrs. Mary D. Hall, of Atlanta, Ga., is a mound 14 feet high, irregular in basal outline, presumably owing to cultivation of the surrounding area. Its diameters of base are 85 feet and 95 feet. Considerable digging failed to show the mound to be other than what it seemed to be, namely, a domiciliary mound.

Over the surface of the field surrounding the mound, debris from aboriginal occupancy was more thickly scattered than we recall having seen in any former experience. In addition to the usual pebbles and fragments of pebbles, we gathered a neatly-made little "celt;" part of a small stone pendant; bits of brass; a knuckle-bone of a deer; several discoidal stones shaped from pebbles; discs made from fragments of earthenware, etc. There were almost innumerable fragments of pottery, many of excellent shell-tempered ware, some of which was black. Some of the sherds bear incised decoration wrought with a rather broad point, but the designs are neither new nor especially striking.

In the level ground around the mound is a cemetery in which we found, from 1 to 2 feet in depth, skeletons, some loosely flexed, some lying at full length on the back. There were also aboriginal disturbances where the bones of a skeleton had been disarranged by a burial made at a later period.

The individuals whose skeletons were found by us evidently had experienced the advantage, or disadvantage, of contact with Europeans, as many of the artifacts buried with them clearly proved.

One skeleton had glass beads at the neck, and a bit of sheet-brass and a lump of hematite nearby; a steel or iron blade of a large knife on the body; a broad

chisel of iron or of steel on the pelvis; and an iron or steel axe a little to one side of the body.

Another skeleton at full length on the back had shell beads around the neck, which, probably, when strung, supported a disc of sheet-copper, 4 inches in diameter, having a central hole, and two perforations for suspension near the rim, which lay nearby. At an ankle and a wrist of this skeleton were a few shell beads. In the clay thrown out from the grave were two triangular sheet-brass pendants, and an annular ornament of the same material, 2 inches in diameter, and having an intervening space where the metal had broken between two perforations for suspension.

Another skeleton had a large number of small sea-shells (*Marginella apicina*)[1] pierced for suspension as beads.

Above the skull of a skeleton was a small slab of stone,[2] rounded to some extent, and four piercing implements of bone, three of which had the articular processes remaining. Below the skull was a triangular slab of stone and a large mussel-shell.

Near a skeleton was an earthenware pipe of ordinary form, undecorated and of most inferior ware.

Realizing that we had to do with burials of comparatively late Indians, we did not push the investigation of this place to the extent we would have done had the cemetery been of an earlier period. The mound we believe to antedate the post-Columbian burials near it.

Mound at Mound Landing, Muscogee County, Ga.

On property of Mr. J. Kyle, of Willet, Ga., in full view from the river, is the remnant of a mound which repeated floods have largely washed away. No investigation was attempted by us at this place, though the mound was courteously put at our disposal by the owner.

MOUNDS AND SITES INVESTIGATED ON FLINT RIVER.

Mound near Log Landing, Decatur County, Ga.

In high swamp, dry in low stages of the river, about one mile in a N. by E. direction from a log landing on the east side of Flint river, one mile approximately above its union with the Chattahoochee, is a mound on property of Mr. L. B. Edwards, of Chattahoochee, Fla.

[1] Kindly identified by Dr. H. A. Pilsbry, of the Academy of Natural Sciences of Philadelphia.

[2] As this object seems to be of small importance, we have not had the stone exactly determined. Incidentally, we may say that exact determination of many rocks demands chemical analysis and the making of slides for microscopic examination. Even then, exact determination is not always arrived at. Determination by inspection alone is a snare. We once submitted to a well-known expert dealer twelve "celts," each marked with a number, and carefully registered the determinations, all which were based on inspection only. Later, the identical twelve "celts" were resubmitted to the same expert who believed them to be a different lot. The determinations of but four coincided with those previously given.

The mound, of sandy clay, about 3.5 feet in height and 50 feet across its circular base, was dug by us to a width of from 3 to 4 feet around its marginal part. In addition, thirteen trial-holes were sunk into the remaining portion. No bones were encountered.

In the soil was the upper part of a so-called hoe-shaped implement which had been broken transversely in a line with the perforation.

Just below the surface of the mound was an undecorated bowl of inferior ware, having a flat, imperforate base. Within the bowl were fragments of shells and a soapstone pipe, undecorated, of a common type, which has a bowl about equaling in size the part intended to hold a stem, both parts being about square in transverse section.

We regarded this bowl and its contents as a cache in a domiciliary mound.

Mound near Munnerlyn's Landing, Decatur County, Ga.

This mound, of sand, 2 feet 9 inches in height and 50 feet across its circular base, on property controlled by Mr. H. C. Allen, of Bainbridge, Ga., was in an old field about one-quarter mile in a southerly course from Munnerlyn's Landing.

The mound, which was completely dug away by us, with the exception of a portion around a small fruit tree, had sustained practically no digging previous to our visit, but evidently had been spread somewhat by cultivation. However, as none of the sixteen burials met with by us in the mound was less than one foot from the surface, it is not likely that any material damage had been wrought by the plow. Some of the skeletons were too badly decayed to enable determination of the form of burial; some indicated a close flexion.

Near a burial was a fragment of a soapstone vessel, worked into an ellipsoidal form, 4.25 inches in length. Below the skull of another burial was the lower part of an earthenware vessel; otherwise, the burials, two of which lay near deposits of charcoal, were not associated with artifacts. Apart from human remains lay: a "celt;" a rude cutting implement of chert; several chips of chert, singly; and a deposit of small masses of chert.

A few feet in from the eastern margin of the mound began a deposit of earthenware, including many small fragments of various vessels, some large parts of vessels, and several entire ones. The ware of all is inferior. Tempering with gravel or with shell is not present. Parts of one vessel show an exterior coating of red paint; the small check-stamp was encountered once; incised or punctate decoration is unrepresented. Several vessels and parts of vessels bear faint, complicated-stamp decoration. Two large fragments have this form of decoration more distinctly marked, one bearing a design showing the human eye (Figs. 25, 26).

Two vessels, the only ones presenting any divergence from ordinary forms, have flat, square bases with pronounced corners serving as feet.

Two small, undecorated vessels were found together, apart from the ceremonial deposit of earthenware and, like all vessels and large parts of vessels from this mound, bear the basal, mortuary perforation.

MOUND NEAR KERR'S LANDING, DECATUR COUNTY, GA.

This mound, circular in outline, almost entirely of sand, with a height of 5 feet 2 inches, a basal diameter of about 62 feet, in a field formerly under cultiva-

FIG. 25.—Sherd. Mound near Munnerlyn's Landing. (Half size.)

tion, forming part of the plantation of Judge B. B. Bower, of Bainbridge, is about 2 miles in a southeasterly direction from Kerr's Landing, and about 5 miles below Bainbridge. A deep excavation about 30 yards west of the mound showed whence its material had come.

FIG. 26.—Sherd. Mound near Munnerlyn's Landing. (Height 8.4 inches.)

The mound, which had been considerably dug into before our visit, was entirely leveled by us with the exception of parts around four trees. Near the center of the base was a former fireplace with considerable charcoal remaining.

Human remains, encountered in twenty-five places, were all so badly decayed that the form of burial was evident in but few instances. The closely-flexed form, however, was represented in some cases, as also probably were bunched burials.

With one burial was a "celt" of volcanic rock, 6 inches in length—the only artifact found in direct association with the dead. With another burial was a mass of material, 8 by 8 by 5 inches, determined by Dr. Harry F. Keller to be "clay mixed with a

few per cent. of carbon in the graphitic form, as well as some coarser and finer grains of quartz sand." "The particles of carbon," says Doctor Keller, "are very fine and pretty thoroughly disseminated through the mass."

With some burials was sand colored with hematite; with others, charcoal.

Not found directly with burials were: two arrowheads or knives, of chert; several flakes of the same material; two masses of galena (lead sulphide) from the carbonate deposit occurring on which the aborigines made white-lead paint; a few scattered sherds; a large deposit of earthenware.

This deposit, beginning near the eastern margin of the mound, as usual, covered a considerable area and extended a number of feet toward the center. It consisted mainly of a great number of fragments of vessels, several hundred at least, and represented parts of many vessels, none of which, so far as we could determine, had a full complement of fragments present. Of course, the determination of the number of fragments of a vessel which may be in a mound is more difficult when a vessel is undecorated or bears a check-stamp decoration, as identifications of adjacent parts is less readily made in such cases than when distinctive decoration aids the investigator. However, it is entirely possible that parts of decorated vessels even escaped our vigilance by being thrown back by shovels with sand, for when sherds are widely scattered, one lying here and one there, the whole area in which they lie cannot be passed through a sieve as can be done and is done by us when fragments of vessels lie more closely together.

Beside the small check-stamp, which greatly predominated, the forms of decoration present on the ware were: a few examples of the complicated stamp, faintly impressed; the cord-marked; several designs with red paint; a few interesting patterns, sometimes incised, sometimes neatly made with the impress of a point or, in some instances perhaps, of a roulette.[1]

Gritty ware was sparingly represented; no shell-tempered ware was found. Here and there in the deposit, farther in than were most of the fragments, were several whole vessels and large parts of vessels. All these had mortuary perforation of base, which was apparent also on many fragments.

Certain sherds had belonged to vessels bearing feet.

Entire vessels and large parts of vessels from this mound will be described in detail:

Vessel No. 1.—The greater part of a bowl which had been surrounded below the rim by a band of rather rudely-executed, incised decoration.

Vessel No. 2.—A pot of inferior ware having a rather faintly-impressed, small check-stamp.

Vessel No. 3.—A bowl of yellow ware, undecorated save for a single, incised line immediately below the rim.

Vessel No. 4.—A bowl of inferior material, rudely decorated with incised, parallel lines below the margin.

[1] "Aboriginal Pottery of Eastern United States," W. H. Holmes, Fig. 43. Twentieth Ann. Rep. Bur. Am. Ethnol., 1898–99.

Vessel No. 5.—A large part of a bowl which has since been somewhat restored, though no part of this restoration shows in the reproduction (Fig. 27). The punctate design, beautifully executed, which is shown in the illustration, appears four times on the vessel. In the base are two carefully-made, circular, mortuary perforations, side by side. Such duplication of the mortuary mutilation is unusual.

Vessel No. 6.—A vessel of excellent, yellow ware, graceful in form (Fig. 28), having an interesting, incised decoration shown diagrammatically in Fig. 29.

FIG. 27.—Vessel No. 5. Mound near Kerr's Landing. (Diameter 10.6 inches.)

Vessel No. 7.—Similar to Vessel No. 6 as to ware and shape, but without decoration. With this were the decaying remains of a large conch (*Fulgur perversum*). Vessels Nos. 6 and 7 were found together somewhat farther toward the center of the mound than the general deposit of earthenware.

Certain vessels have been made up with partial restoration, from fragments present in the mound, as follows:

Vessel No. 8.—A pot of inferior ware having for decoration on the upper part rudely-incised, parallel lines crossed by parallel, diagonal ones.

FIG. 28.—Vessel No. 6. Mound near Kerr's Landing. (Height 7 7 inches.)

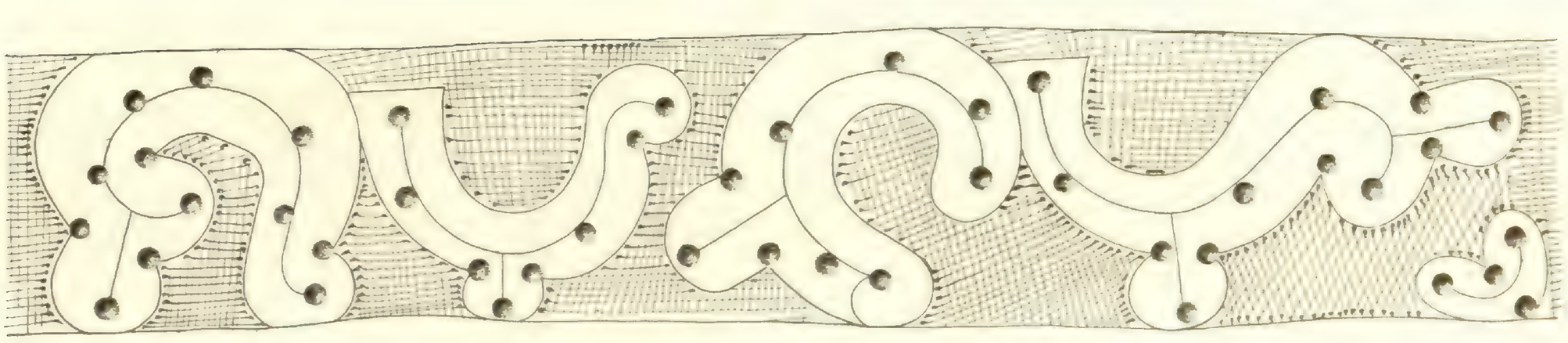


FIG. 29.—Vessel No. 6. Decoration. (About one-third size.)

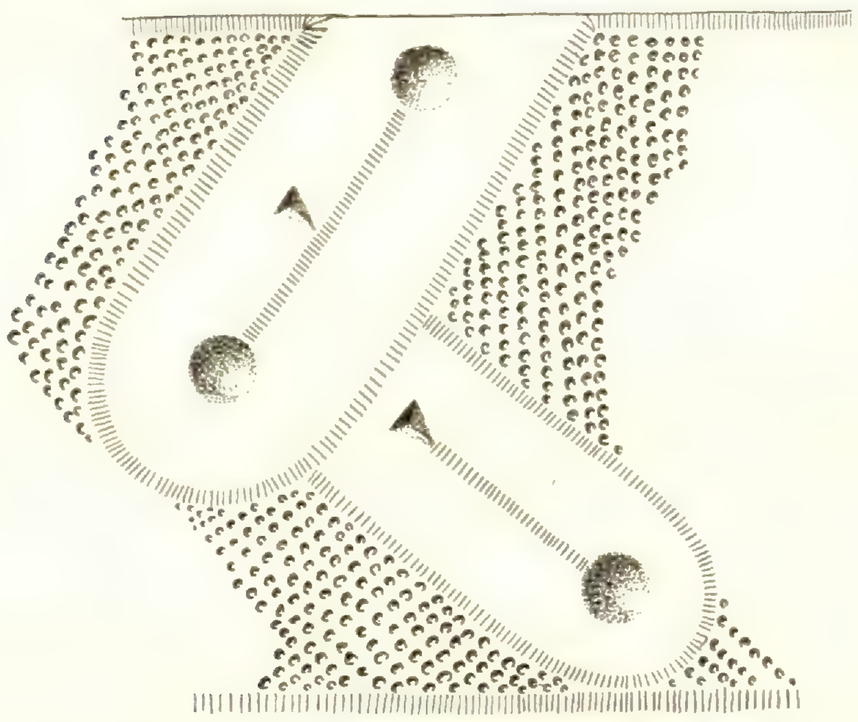


FIG. 30.—Vessel No. 10. Decoration. (About two-thirds size.)

Vessel No. 9.—A dish or platter, 8 inches square, having a slightly concave base, and two knobs on opposite sides, rising above the rim. There has been a decoration consisting of broad bands of red pigment, which we have been unable to restore owing to the absence of the central part of the dish.

Vessel No. 10.—A bowl of excellent ware having a carefully-executed, punctate design, shown in Fig. 30, a number of times repeated.

Two sherds from this mound are shown in Figs. 31, 32.

BURIAL PLACE ON THE CHASON PLANTATION, DECATUR COUNTY, GA.

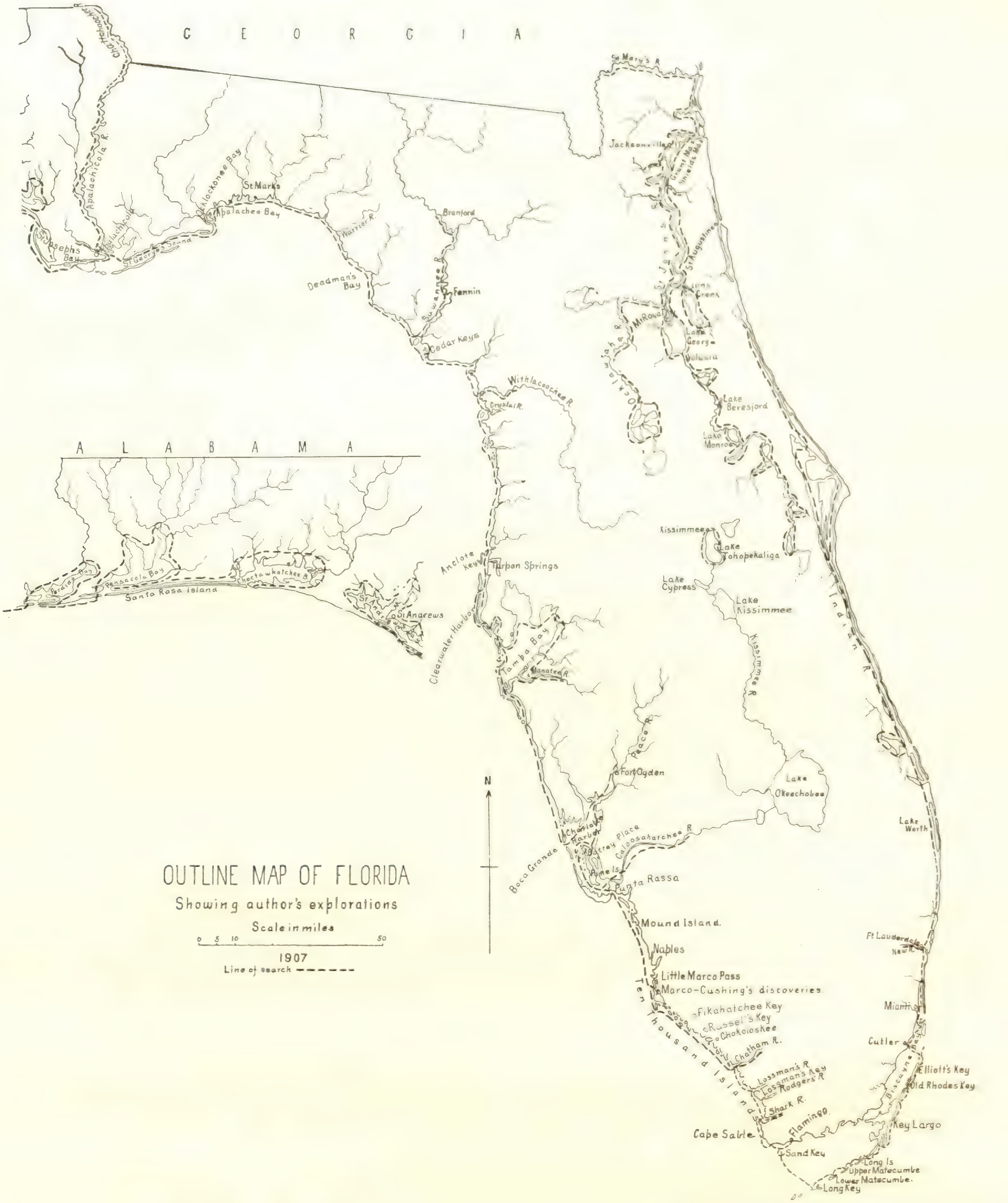
The Chason Plantation, belonging to Dr. Jefferson D. Chason, of Bainbridge, is on the eastern side of Flint river, about 3.5 miles below the city named. A slight rise in the ground in a cotton-field forming part of the plantation was reported

FIG. 31.—Fragment of vessel. Mound near Kerr's Landing. (Half size.)

FIG. 32.—Sherd. Mound near Kerr's Landing. (Half size.)

to be the spot where two earthenware vessels on exhibition at Bainbridge had been found.

Trenching and careful sounding with iron rods over the whole surface of the higher ground resulted in the discovery of two decaying skeletons and part of an earthenware vessel.



OUTLINE MAP OF FLORIDA

Showing author's explorations

Scale in miles

0 5 10 50

1907

Line of search ------

NOTES ON THE TEN THOUSAND ISLANDS, FLORIDA.

By Clarence B. Moore.

The Ten Thousand Islands, which have been twice visited and twice written of by us,[1] were again the subject of our investigation during two seasons, the winter of 1906 and the winter of 1907. These islands (see accompanying map) fringe the coast of southwestern Florida for about 80 miles, along parts of the counties of Lee and Monroe, between the settlement known as Naples on the north and Cape Sable on the south.

In a former report we have spoken of Little Marco as the northern limit of the Ten Thousand Islands, but as the coast is bordered by small keys to Naples, about nine miles farther north, and as this place can be reached by an inside water-route, the most intelligent inhabitants of the Keys now speak of the Ten Thousand Islands as beginning at Naples.

Little Marco, it should be said, is not a key, but a settlement on the mainland, not far from Key Marco. The island next above Marco is not named Little Marco, but is known as "The Beach."

The settlement of Marco, at the northeastern extremity of Key Marco, the most important key of the Ten Thousand Islands, was again visited by us and a careful search made of all the shell territory adjacent. Near Marco we examined a section of a heap composed partly of shell and in part of kitchen refuse and the debris of fires, the last consisting of fine ash containing fish-bones, etc. In this midden refuse were numerous fragments of pottery of rather inferior ware, some bearing a simple incised decoration, others the imprint of cord. No doubt the key-dwellers used pottery only to a limited extent.

Among objects obtained by us at Marco were many pendants, two of which, of limestone, and two of shell, are shown in Figs. 1, 2, 3, 4.

As we have written in former reports, we gravely doubt that the grooved objects of shell and of stone, known as "plumb-bobs," among the keys, of which such great numbers have been found there, were used as sinkers for lines or fish-nets, though some are so coarsely made as to seem unfitted for ornament. Mr. Cushing,[2] among his wonderful discoveries at Marco, found fish-nets with sinkers in place, but none was in the form of the pendants found among the keys, while lines had sinkers of *Turbinella* shells with the whorls rudely battered off. The pendants are not found chiefly near the water, but distributed over such of the keys as have

[1] "Certain Antiquities of the Florida West-Coast." Journ. Acad. Nat. Sci. of Phila., Vol. XI, 1900.

"Miscellaneous Investigation in Florida." Journ. Acad. Nat. Sci. of Phila., Vol. XIII, 1905.

[2] "Preliminary Report on the Exploration of Ancient Key-Dweller Remains on the Gulf-Coast of Florida," by Frank Hamilton Cushing. Proceedings of the American Philosophical Society, Vol. XXXV, No. 153, p. 38, 1897.

aboriginal deposits of shell; some are too handsomely made to have served a utilitarian purpose; while one in our possession is of a coralline material so light that it hardly sinks in water. We found in the cemetery and mound near Crystal River,[1] Florida, in place on a skeleton, a number of stone pendants associated with others made of copper. We believe these pendants from the keys served some ornamental or ceremonial purpose—perhaps they were "charm-stones." It is true, as we have said, that many of the stone pendants of the keys are crude, but much of the stone of that locality is not of a character conducive to good workmanship.

FIG. 1.—Pendant of limestone. Marco, Key Marco. (About full size.)

FIG. 2.—Pendant of limestone. Marco, Key Marco. (About full size.)

FIG. 3.—Pendant of shell. Marco, Key Marco. (About full size.)

FIG. 4.—Pendant of shell. Marco, Key Marco. (About full size.)

Two interesting pendants from Marco probably represent ducks' heads. One (Fig. 5) is of a hard stone not found in Florida, but we have not wished to mutilate it for exact determination. The other, of limestone, is shown in Fig. 6. These pendants are another of the indications of the high esteem in which the duck was held by the ancient southern Indians.

FIG. 5.—Duck-head pendant. Three positions. Marco, Key Marco. (Full size.)

A circular ornament of shell from Marco, and a curiously-shaped pendant of limestone from the same place, are shown in Figs. 7, 8, respectively.

[1] "Certain Aboriginal Mounds of the Central Florida West-Coast." Journ. Acad. Nat. Sci. of Phila., Vol. XII, p. 99, 1903.

Occasionally in the shell debris at Marco were "chipped and notched fragments of heavy clam-shells," like those found by Cushing[1] on nets in the muck at Marco; while a fossil-shark's tooth, beveled and showing signs of use, probably as a knife, was picked up by us in the shell debris of a cultivated field. Teeth of sharks, though fossil

FIG. 6.—Duck-head pendant. Three positions. Marco, Key Marco. (Full size.)

FIG. 7.—Ornament of shell. Marco, Key Marco. (About full size.)

sharks are not specified, were found by Cushing,[2] set in handles for use as carving tools.

We got also at Marco—and the inhabitants say that many have been gathered from the surface near there—a fragment of clam-shell wrought on one side to a very sharp cutting edge (Fig. 9). These probably were hafted as knives or, perhaps, were the blades of small hand-adzes, as described by Cushing,[3] though "little blades made either from bits of shell, the sharp ventral valves of oysters," and not clam-shells, are mentioned by him.

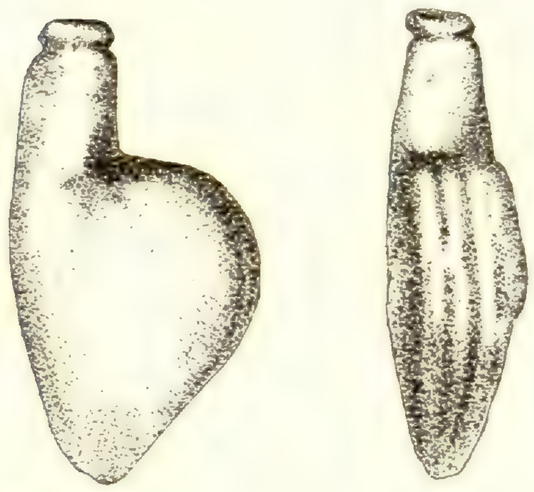


FIG. 8.—Pendant. Two positions. Marco, Key Marco. (Full size.)

FIG. 9.—Chisel blade and section. Marco, Key Marco. (Full size.)

While at Marco we visited Little Marco; McIlvaine's Key; Addison's Key; and the Crawford place, northward toward Naples—all noteworthy, aboriginal shell deposits.

A number of interesting objects came from Goodland Point, Key Marco, among which is a gorget of shell (Fig. 10) with the aboriginal sign of the four directions.

A pendant from the same place (Fig. 11), made from fossil bone or from some coral material (we have not wished to cut into the specimen to determine it), bears an incised design on each of the four sides—two showing the eye; one, a mouth or jaws; and one being indistinguishable. Three of these designs are shown in diagram in Fig. 12.

[1] *Op. cit.*, p. 38. [2] *Op. cit.*, p. 42. [3] *Op. cit.*, p. 41.

Fikahatchee Key, and Russell's Key, large shell islands, yielded specimens of aboriginal work.

Chokoloskee Key was visited with good results. Among various objects obtained there was a gorget wrought from a considerable portion of a shell (somewhat similar to the shells we found in the great place of burial near Crystal River, Florida), which resembles a shallow

FIG. 10.—Gorget of shell. Goodland Point, Key Marco. (Full size.)

FIG. 11.—Pendant. Goodland Point, Key Marco. (About full size.)

drinking-cup and might be taken for such an object were it not for two holes for suspension bored well below the margin.

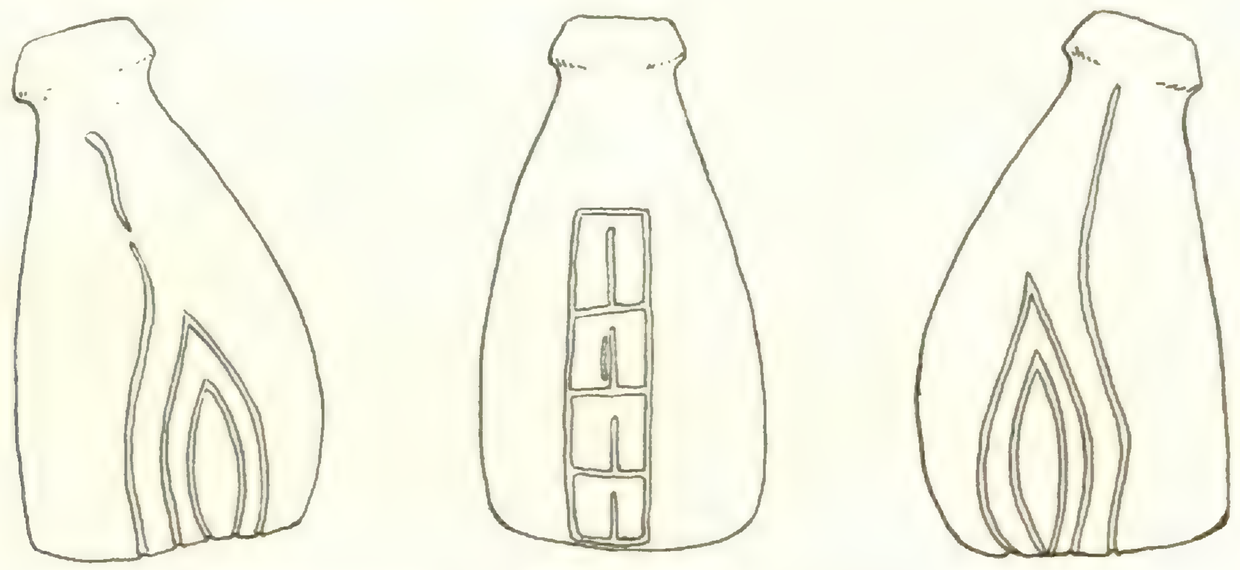


FIG. 12.—Incised decoration on pendant. Goodland Point, Key Marco. (Full size.)

An interesting object from Chokoloskee Key, a massive pick 6.7 inches in length and 1.25 inches in maximum thickness, wrought from the lip of *Strombus*

gigas, is shown in Fig. 13. Much splintering at each end testifies to the amount of service to which this implement has been subjected. It is our belief, strengthened by the result of inquiry, that this shell implement is unique, though similarly shaped picks of stone are met with.

FIG. 13.—Pick-axe of shell. Chokoloskee Key. (Full size.)

A pendant from the same place is a carefully-made imitation, wrought from shell, of a canine tooth of a large carnivore. So well executed is this imitation that at first glance one might well be deceived and mistake it for a tooth in reality (Fig. 14).

Also from Chokoloskee Key came a pendant of a hard stone from a region to the north of Florida (Fig. 15); a pendant of shell (Fig. 16); a well made bead of shell (Fig. 17); an ornament of shell with the incised sign of the four directions (Fig. 18).

FIG. 14.—Pendant of shell. Chokoloskee Key. (Full size.)

FIG. 15.—Pendant of stone. Chokoloskee Key. (About full size.)

FIG. 16.—Pendant of shell. Chokoloskee Key. (About full size.)

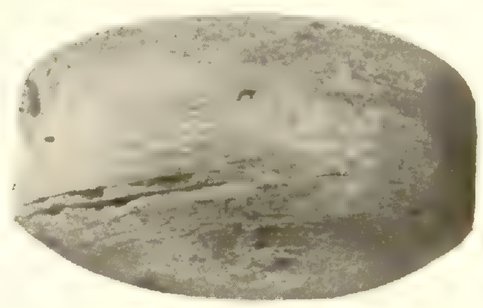


FIG. 17.—Bead of shell. Chokoloskee Key. (About full size.)

A rude effigy of a human head (Fig. 19), carved on a fragment of pumice stone, was picked up on Chokoloskee Key by a thoroughly reliable person long known to us, from whom we obtained it. This effigy has every appearance of being aboriginal work.

Lossman's Key, near Cape Sable, one of the largest keys of the Ten Thousand Islands, was again visited by us and its two shell deposits—one more than ten acres in extent—were carefully examined. The larger deposit, rich in aboriginal implements, has been recently cleared of the hammock growth formerly upon it. While there we almost walked upon the wires of a loaded spring-gun set for deer or panther—one of the chances one takes in exploring this wild and lawless region.

The reader of our former reports on the Florida Keys may recall that in the shell deposits there are many implements wrought from entire shells. These implements, sometimes whole, but much oftener broken or greatly worn, lie among great numbers of unwrought conchs and other shells, as is well shown in the picture of a cultivated field on Chokoloskee Key (Fig. 20).

FIG. 18.—Ornament of shell. Chokoloskee Key. (About full size.)

In our search for these implements we were constantly aided by the inhabitants—especially by children who, laboring in hope of substantial reward, had put aside, to await our coming, all desirable shells found on the surface or turned up by the plow. In this way, by our own efforts and by those of others we accumulated a very large collection of implements. These implements we believe to have served mainly as chisels, gouges, adzes, scrapers, hammers, and grinders, and especially as hoes and picks in the cultivation of the soil. These picks and hoes were used with fairly short handles, those employing them assuming a squatting position, after the manner of less-advanced peoples at the present time when cultivating the ground.

FIG. 19.—Head of pumice stone. Chokoloskee Key. (2.2 inches high.)

The results of our two seasons' labors were added in part to our collection in the Academy of Natural Sciences in Philadelphia and in part were sent to various museums in this country, in South America, and in Europe.

Before describing new types of shell implements found by us in our last two seasons' work, we wish to correct an error into which we have fallen. In a former report[1] we say, "There is a small hole above the shoulder, or periphery [of the shell], which seems, as a rule, to have had no connection with the tool, inasmuch as numbers of shells, not made into implements, show a similar perforation, which may have been made to sever the muscle and free the shell-fish from its shell."

[1] "Miscellaneous Investigation in Florida," page 316. Journ. Acad. Nat. Sci. of Phila., Vol XIII, 1905.

FIG. 20.—A field on Chokoloskee Key.

While it is true that some conch shells (more from some localities than from others) which have no hole or holes in the body-whorl for the insertion of a handle, and do not seem to have served as tools, have a small hole above the shoulder, or periphery, it is equally true that a large proportion of the shells found on the keys do not have this hole, and, as the contents of these shells were brought to the keys as an article of food, it is clear that a hole above the shoulder, or periphery, was not necessary to separate the shell-fish from the shell.

Cushing,[1] who found in place in the muck at Marco shell implements pierced for handles, speaks of them as follows: "Thus the stick or handle could be driven into these perfortions, past the columella in such manner that it was sprung or clamped firmly into place. Nevertheless it was usually further secured with rawhide thongs —now mere jelly—passed through one or two additional perforations in the head, and around both the stick and the columella."

This hole above the shoulder is not always present, however, even in shells which are distinctly tools, with chisel-edge and holes, or a hole and a notch, for the insertion of a handle. This hole for the thong is absent in a small percentage of these tools among the islands generally, while at McIlvaine's, a small shell key[2] about two miles to the northeast of the settlement of Marco, a score of implements, all that were found by us of the class we have mentioned, had no hole above the shoulder of the shell.

We shall now describe in detail some of the most interesting shell implements obtained by us since the publication of our last report.

An interesting type from Marco is a pick wrought from *Fasciolaria* (Fig. 21), doubtless used in cultivating

[1] *Op. cit.*, p. 40.

[2] The reader will bear in mind that a very small proportion of the keys of the Ten Thousand Islands bear evidence of aboriginal occupancy.

FIG. 21.—Shell pick. Marco, Key Marco. (Length 11.7 inches.)

the soil. These picks are seldom found entire, though implements of the same shell with the columella much worn away are abundant. It is likely that picks, after a certain amount of wear, were used as hammers.

The next implement to be considered, a heavy *Fulgur perversum* of moderate size, differs from types heretofore described in that there is a hole for the handle, back of the columella, and a notch on the right as shown in Fig. 22, illustrating a

FIG. 22.—Implement of shell. McIlvaine's Key. (Height 5.5 inches.)

specimen from McIlvaine's Key. Usually when a notch is present it is on the left of the shell. A number of examples similar to the one shown in the figure, however, were met with by us on McIlvaine's Key and elsewhere. There is no hole in the upper part of the shell for a thong or fiber to pass through, and none is needed in this instance as attachment can be made directly to the columella.

An interesting implement is a *Fulgur perversum* with no perforation for a handle below the shoulder, or periphery. There is, however, in addition to the

usual small hole for attachment, a large one above the shoulder, a feature often found on the eastern coast of Florida, but seldom on the western coast. This tool, which came from Fikahatchee Key, perhaps was used like a spade the handle extending straight upward; or possibly the shell was placed at right angles to the handle which crossing the top of the shell entered the hole obliquely and was made fast with a thong.

FIG. 23.—Shell implement. Goodland Point. (Length 11.35 inches.)

An implement (Fig. 23) from Goodland Point, Key Marco, has no hole of any sort and consequently no inserted handle was used in connection with it. The upper, and heavier, part of the shell shows great wear, but as the beak is intact, bearing no trace of a cutting edge or of any use whatever, it is evident the tool was not used with the upper part held in the hand and the lower part to cut as a chisel, or to loosen the soil as a pick, as some tools closely resembling this one certainly were used. Therefore, we are inclined to believe the tool to have been employed as a kind of hammer or grinder, but as there is no evidence of chipping or battering, presumably it served in connection with some comparatively soft material, such as Indian corn.

An implement (Fig. 24), wrought from *Fasciolaria*, is greatly cut away for convenience to the user and has a notch to the right and another to the left for the attachment of a handle. At Lossman's Key, from which this implement came, it was noted that a double notch was used more often than a hole and a notch or a double hole for the handle.

As we have said before in this report, the small hole, or sometimes two holes, in the shell above the shoulder, or periphery, through which thongs or fiber bound the handle more firmly, were not always employed. Almost invariably when these holes

for attachment were not made above the shoulder, they were dispensed with, though in a few cases they are found in the body of the shell. A small number of such instances have come to our notice, and there is in our collection at the Academy of Natural Sciences a good example from Fikahatchee Key, where a shell with a fine gouge edge, and a hole and a notch to accommodate a handle, has a small, round perforation in the body-whorl—too small to have served for any purpose except for the passage of a thong.

FIG. 24.—Shell implement. Lossman's Key. (Length 6.2 inches.)

Two shells (*Fulgur perversum*) added to our collection since the last report, differ from ordinary types in that while both have edges beautifully ground at the beaks, and each has a part of the body-whorl cut back from the aperture, neither shell bears hole or notch for the accommodation of a handle. One implement, however, has a hole for attachment above the shoulder of the shell, while the other is without one. These implements came respectively from Little Marco and the Crawford Place, below Naples.

As to another class of shells we are unable as yet to reach a decision. These shells, sparingly found on the Ten Thousand Islands, were fairly numerous on Wason, or Cora Key, in Pine Island Sound, north of the Ten Thousand Islands. The shells (*Fulgur perversum*) are carefully cut back from the aperture as if for use as tools and have above the shoulder usually one small hole, but sometimes two, for attachment. In certain cases some of these holes seem to bear evidence of wear. On the other hand, in no instance do these shells have any hole or notch through which a handle may be passed. The beaks are considerably chipped as if by use, but above the splintered part is no sign of the remainder of the ground surface, which is so often apparent on other tools, though they have been subjected to prolonged use. It is possible these shells were used as tools with the aid of a handle abutting against the inside of the body-whorl, the thong extending over the outside of the shell. Presumably the beaks were not ground prior to use, the implements serving as picks with unground beaks, as was the case with the large "horse-conchs" (*Fasciolaria*), one of which is shown in this report (Fig. 21).

On all the shell keys, and notably on Fikahatchee Key, we found masses of sandstone, smoothed and furrowed by use. These stones, we believe, were those used in conferring cutting edges on the shell tools of the keys.

Fig. 25 shows an ordinary southern, round clam-shell (*Venus mortoni*) from Fikahatchee Key, with a circular hole knocked from the inside through the central part of the shell or, perhaps, a little above it. Clam-shells of this kind, of which we obtained thirteen,—twelve from Chokoloskee and one from Fikahatchee,—usually show considerable wear on parts of the edge, though the shell in the illustration, probably almost an unused tool, shows but little sign of use. There seems to be, however, no evidence of wear on the sharp edges within the holes, which fact makes it still more doubtful how these shells were used, though no doubt the purpose for which they were employed was the cultivation of the soil. In "Art in Shell" [1] we see suggested various methods of hafting perforated shells.

Cushing says:[2] "Large clam-shells, deeply worn at the backs, as well as showing much use at the edges, seem to have served both as scrapers and as digging implements or hoes; for some of them had been hafted by clamping curved sticks over the hinge and over the point at the apex, or umbo—where it showed wear" . . . No reference is made by him to holes in these shells, and in point of fact repeated search made by ourselves and by the juvenile population of Marco[3] failed to discover at that place a single perforated clam-shell of the variety in question.

FIG. 25.—Shell implement. Fikahatchee. (Length about 5 inches.)

Cushing,[4] however, speaks of varieties of *Pectunculus* (which is a kind of clam) as having served as scrapers and shavers, and being "perforated at the apices, in order that a loop might be attached to them to facilitate handling," and also describes (p. 42) a variety of *Arca* shell, three and one-half or four inches long, through the aperture of which a strip of bark was passed in a way to afford an excellent grasp. Probably it was in this manner our clam-shells were used and the comparative absence of wear in the holes is owing to the soft character of the fiber.

One feature connected with the thirteen clam-shells found by us is of especial interest. Of these shells twelve are left valves, having the umbo, or beak (which in the case of the clam is above the heavy hinge-piece) turning to the right of the user, thus making it perhaps a trifle easier for a right-handed person to grasp in connection with a band. In the case of the remaining shell, a right-hand valve,

[1] W. H. Holmes. Rep. Bur. Am. Ethn., 1880–81, pp. 206–207, plate XXVI.
[2] *Op. cit.*, p. 40.
[3] Marco was the principal scene of Mr. Cushing's labors.
[4] *Op. cit.*, p. 42.

the beak turns to the left of the user, and probably was selected by a left-handed individual.

In Fig. 26 is shown a shell (*Codakia orbicularis*) which has been an implement of some sort. This shell was dug by us from one of the great ash-heaps on Chokoloskee Key, which there and on certain other keys seem to be the remains of fires long continued.

FIG. 26.—Shell implement. Chokoloskee Key. (About full size.)

Spread over the shell keys are considerable numbers of shells (*Arca ponderosa*), many with a hole below the hinge, as shown in Fig. 27.

Cushing (p. 38) speaks of nets having "sinkers made from thick, roughly perforated umboidal bivalves, tied together in bunches," no doubt referring to the *Arca ponderosa* shell.

The number of these shells having holes, when found on the shell keys, greatly preponderates over those that do not have a perforation, in which they greatly differ from the conchs and other large shells found on the keys. The reason for this is plain. The larger shell-fish were selected for food primarily, and the shells of only some of them were subsequently used as tools. The *Arca*, on the other hand, is small and moreover is found in comparatively deep water when alive. Presumably conditions were such that the *Arca* was not sought as food and the supply of shells needed for tools came from the beaches. In this event a very large proportion of the shells carried to the keys would be perforated for use.

FIG. 27.—Perforated *Arca* shell. Little Marco. (Length 2.15 inches.)

Many of the *Arca ponderosa* shells in our possession show decided wear on the edges, which leads us to believe they were used as diminutive scrapers. Probably *Arca* shells were employed for different purposes—for tools as well as for net-sinkers.

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Moundville Revisited; Crystal River Revisited; Mounds of the Lower Chattahoochee and Lower Flint Rivers; Notes on the Ten Thousand Islands, Florida. Journ. Acad. Nat. Sci. of Phila., 1907. Vol. XIII. Quarto, 144 pages. Maps, illustrations in text.

Certain Mounds of Arkansas and of Mississippi (including Doctor Hrdlička's paper on the Crania). Journ. Acad. Nat. Sci. of Phila., 1908. Vol. XIII. Quarto, about 120 pages. Maps, illustrations in text, eight colored plates.

Certain Mounds of Arkansas and of Mississippi

Part I

Mounds and Cemeteries of the Lower Arkansas River

Part II

Mounds of the Lower Yazoo and Lower Sunflower Rivers, Mississippi

Part III

The Blum Mounds, Mississippi

BY

CLARENCE B. MOORE.

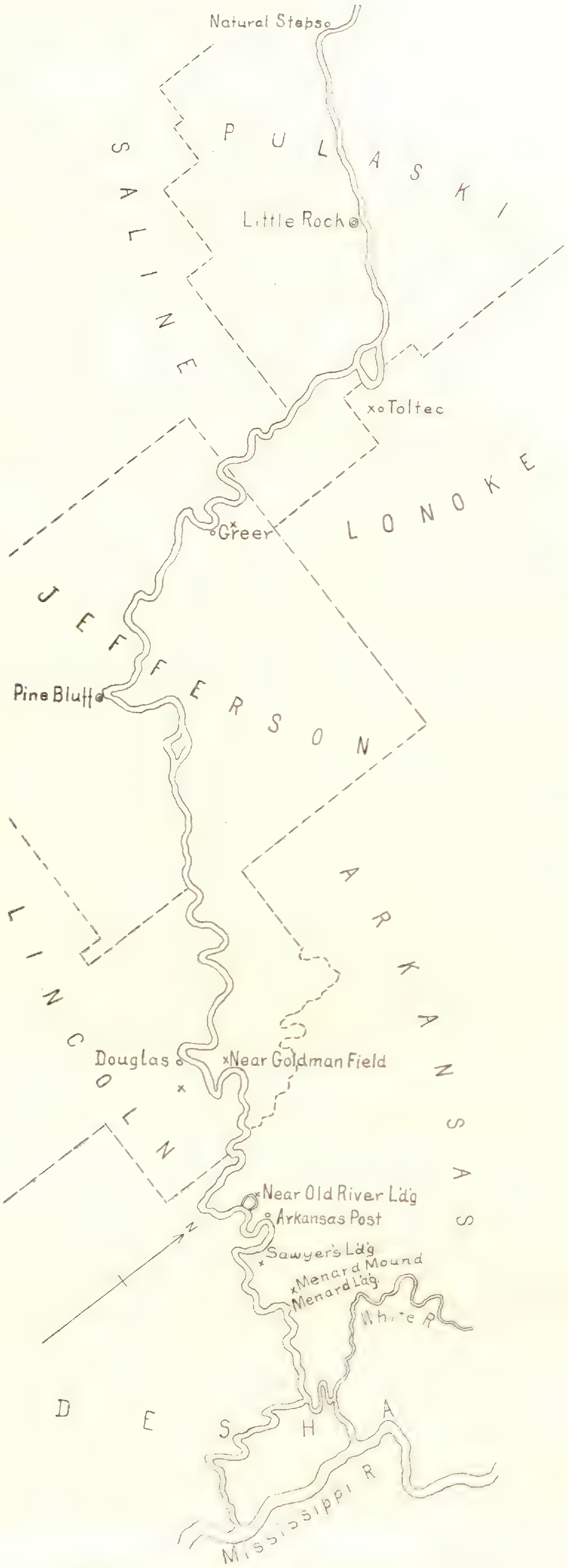
PHILADELPHIA
1908.

PART I

Mounds and Cemeteries of the Lower Arkansas River

BY

CLARENCE B. MOORE.



MAP OF LOWER PART OF THE ARKANSAS RIVER

Scale in miles

0 5 10 15 20

1909

CERTAIN MOUNDS OF ARKANSAS AND OF MISSISSIPPI.

By Clarence B. Moore.

PART I.

Mounds and Cemeteries of the Lower Arkansas River.

When it became evident that our quest on the Yazoo and Sunflower rivers in the State of Mississippi (described in the latter part of this report), was not destined to succeed, we turned to the Arkansas river.

This river we investigated as far up as Natural Steps, twenty miles above the city of Little Rock, Arkansas, a distance of 194 miles by water, according to the Government survey. This survey, however, was made long ago, and the river in recent years, by cutting its way across bends, has shortened its course; therefore, the distance gone over by us was considerably less than the figures given.

The time spent on this work, in our flat-bottomed steamer, with thirteen men to dig and four to supervise, was fifty-six[1] days, including parts of February and April, and all of March, 1908.

Our custom to send agents in advance to find the exact locations of mounds, had not been followed in the case of those on the Arkansas river.

With the exception of the Menard mound, and the so-called Toltec group below Little Rock, the mounds on the Arkansas river between its mouth and Natural Steps (that part of the river with which this report has to do), are insignificant in number and in size; while aboriginal cemeteries, as to the location of which a clue could be had, were far from numerous. The river is constantly changing its course, and many mounds and cemeteries, no doubt, have been swept away in the past or have been left far inland.

When Marquette,[2] the first of the French explorers of this region, visited the aborigines not far from the Arkansas River, in 1673, he found them cooking Indian corn "in large earthen pots very curiously made." "They have also," we are

[1] Including four days on the White and LaGrue Rivers.

[2] B. F. French, Historical Collections of Louisiana, Part II, p. 295. To those who have not access to the original French in Margry's "*Découvertes*," the "Historical Collections of Louisiana," edited by B. F. French, will be of interest. The five parts appeared, respectively, in 1846, 1850, 1851, 1852, 1853. The reader, however, must bear in mind that the "Collections" contain misprints and mistranslations, and that incorporated in Part I is the fictitious account by Father Hennepin of a journey by him down the Mississippi to the Gulf, which journey the mendacious friar never accomplished.

A second series edited by B. F. French, "Historical Collections of Louisiana and Florida," two volumes, one published in 1869, one in 1875, complete these "Collections."

told, "large baked earthen plates, which they use for different purposes. The men go naked and wear their hair short. They pierce their noses and ears, and wear rings of glass [1] beads in them."

At nearly every site investigated by us were found beads of glass and objects of brass—sure signs, as the reader is aware, of contact between the aborigines and white men.

Human remains found by us along the Arkansas river were usually so badly decayed as to be worthless for scientific investigation.

A number of skulls, however, were preserved and were sent by us to the United States National Museum at Washington, D. C.

Dr. Aleš Hrdlička has kindly sent us an interesting and complete report on these skulls, which follows this portion (Part I) of our description of the season's work.

At one place, Greer, certain evidence [2] was found by us of the presence of a specific disease which affects the bones, this evidence being strongly marked in the case of a single skeleton, many of whose principal bones were seriously involved.

We attach but little importance to this discovery of diseased bones, however, inasmuch as Greer cannot, with reasonable certainty, be classed as a pre-Columbian site. It is true that no European artifacts, such as glass, brass, iron or lead, were found there by us; and that the copper beads (present with one burial only) have been shown by the analysis of Dr. H. F. Keller to be pure native copper with only a trace of iron, hence far purer than any product from the smelted sulphide ores of Europe could have been in early times, or indeed could be at the present time.

Still, as almost nothing except pottery (which does not determine their period) had been placed with the burials at Greer; and as the native copper beads, found in but a single instance, cannot be regarded as more than an indication; and as all other sites of importance investigated by us on the Arkansas river were, as we have said, distinctly post-Columbian, the question of contact between Europeans and the makers of the cemetery at Greer must be considered an open one.

In the way of artifacts, but little save earthenware lay with the dead in the graves along the lower Arkansas, the aboriginal mourners, seemingly, having considered their duty fully performed by depositing pottery alone.

Vessels were not always present with the dead, though in the great majority of cases they were so found, sometimes singly, often in pairs (usually a bottle and a bowl); occasionally in greater number, ten in one instance having been found with a single burial. The smallest vessels usually accompanied the remains of children.

[1] In another translation of Marquette's narrative the word "glass" is omitted, the statement being that the natives wear beads hanging from their noses and ears (Hist. Coll. of La., Part IV, page 48). In the original French the word *rassade* is used. This word is defined as "beads of glass or of enamel" by Littré; and practically the same definition is given by the Dictionary of the French Academy. *Nouveau Larousse Illustré* gives *rassade* as meaning glassware for trading purposes. Nevertheless it is just possible that Marquette, though lately from Canada where glass beads on Indians must have been a familiar sight, may have used the word *rassade* in describing beads of shell or the pierced pearls often worn by aborigines. The Arkansas and the White rivers are today famous for their yield of pearls.

[2] As attested by the United States Army Medical Museum where the bones now are.

As a rule, vessels lay near the skulls; and even in bunched burials, the vicinity of a skull was often selected as the place of deposit. This rule, however, had many exceptions, and in some sites vessels were found at almost every part of the skeleton, as may be seen in the detailed accounts of our investigation, which are to follow.

As we have already said, practically all the cemeteries investigated by us on the lower Arkansas river extended into the post-Columbian period, a fact, however, which had little to do with the earthenware of the cemeteries, as has been well expressed by Professor Holmes.

"There is but little evidence of the influence of the art of the whites," he says,[1] "upon the ceramic products of this province, although the forms are sometimes thought to be suggestive of European models. It is certain, however, that the art had reached its highest stage without the aid of civilized hands, and in the study of its many interesting features we can feel assured that we are dealing with purely aboriginal types."

The earthenware of the lower Arkansas river, in common with that of all the middle Mississippi region, was not "killed" by breaking a hole in the base or by making one there prior to the firing of the clay; nor was it broken ceremonially before inhumation.

The ware, shell-tempered, is not, in our opinion, equal to the best we have found elsewhere (notably at Moundville, Ala., and along the northwestern Florida coast), being less thin, less evenly fired, and often having the tempering material irregularly distributed, as if by imperfect kneading of the clay.

The dark ware with a highly polished coating, which sometimes is found in Mississippi and in Alabama, is scarcely met with along the lower Arkansas.

However, although the ware as a whole is, as we have said, inferior to that sometimes found elsewhere, we nevertheless encountered in our investigation a number of well-tempered, well-fired, and carefully-wrought vessels, which among others, will be particularly described and figured later in this report.

In form, the pot, the bowl, and the bottle greatly predominate, the long-necked bottles, or carafes, being comparatively numerous. We find also the life-form, sometimes in combination with the bottle; and we meet with eccentric forms, occasionally.

An interesting type along the Arkansas river is the "teapot" form of vessel, which has a more-or-less globular body; a circular opening on top, surrounded by a low neck; and a spout and small knob on opposite sides[2] of the body.

[1] W. H. Holmes, "Ancient Pottery of the Mississippi Valley," Fourth Ann. Rep. Bur. Am. Ethnol., p. 371.

In addition to the above-named work we would call attention, in connection with the pottery of the lower Arkansas river, to "Pottery of the Middle Mississippi Valley," in W. H. Holmes' "Aboriginal Pottery of Eastern United States," Twentieth Ann. Rep. Bur. Am. Ethnol.; also "Pottery from Arkansas," by the same author, in Third Ann. Rep. Bur. Am. Ethnol.; Gates P. Thruston, "Antiquities of Tennessee"; Dr. Edward Evers, "Archæology of Missouri, Part I, The Ancient Pottery of Southeastern Missouri"; Charles C. Willoughby, "An Analysis of the Decorations upon Pottery from the Mississippi Valley," Journal of American Folk-Lore, Vol. X, 1897.

[2] Two vessels of this form are figured by Holmes as coming from near the Menard mound, Arkansas river. Third Ann. Rep. Bur. Am. Ethnol., p. 482.

"The origin of this form of vessel," says Professor Holmes,[1] "is suggested by a fine red piece from 'Mississippi,' now in the National Collection. The knob is the head of a turtle or other full-bodied reptile, and the spout takes the place of the creature's tail. Many of the animal-shaped vases would resemble this form closely if an opening were made through the top of the body and through the tail."

This animal-form "teapot" referred to by Professor Holmes, is figured by him in a later work.[2]

We found on the lower Arkansas twenty-eight of this "teapot" form of vessel, ranging in size between the mere toy but 1.9 inches in height, and the capacious vessel 7.6 inches high; some of dark ware; some of yellow ware having a solid coating of red; others of yellow ware decorated with red and white; and in two instances with red, white and black. There were also two life-forms with spouts. The more noteworthy of these "teapot" vessels will be described in their proper places.

We believe this novel "teapot" type, so far as the United States[3] is concerned, to be peculiar to eastern Arkansas and nearby regions.[4] As we went westward on the river, the type was less often met with, only one being found in the cemetery at Greer. We have seen a few said to have come from near the city of Little Rock. In photographs of two large collections of pottery from Arkansas, west of Little Rock, the "teapot" form appears but once.

A large percentage of the pottery of the Lower Arkansas is undecorated.[5] When decoration is present it consists of the use of pigment, or of designs conferred by a pointed implement, sharp or blunt. In the case of some vessels found in one site, incised decoration with red pigment rubbed into the lines was encountered.

The pigments employed, as Professor Holmes[6] points out, were generally clays, white or tinted with iron oxide. Dr. H. F. Keller has made for us eight determinations and analyses of coloring matter on vessels from the lower Arkansas and of various masses of white and of red material which we found with skeletons, sometimes carefully stored in vessels. The red pigment is oxide of iron; the white pigment is clay. One of the masses of red material "is very intense in color and contains more than sixty per cent. of ferric oxide, the remainder being silica and alumina. This material is undoubtedly red ocher."

[1] Fourth Ann. Rep. Bur. Am. Ethnol., p. 403.

[2] Twentieth Ann. Rep. Bur. Am. Ethnol., Plate XL, b.

[3] Compare vessels with spouts, from Panuco Valley, Mexico. Jesse Walter Fewkes, "Certain Antiquities of Eastern Mexico." Twenty-fifth Ann. Rep. Bur. Am. Ethnol., Plate CXXVII, a, b.

Also compare vessels, with single and double spouts, from Central America. Catalogue of Collection of Señor Arango, Medellin, Colombia.

[4] Holmes describes one as coming from "Mississippi." Fourth Ann. Rep. Bur. Am. Ethnol., p. 403.

See also two "teapot" vessels from Coahoma County, Miss., which county borders the Mississippi river. Charles Peabody, "Exploration of Mounds, Coahoma County, Mississippi," Peabody Museum Papers, Vol. III, No. 2. Plate XIV.

[5] Undecorated vessels, commonplace in shape and so poorly fired that after their long deposit in water-soaked ground, they were hardly more than paste, were sometimes the principal yield from a day's work.

[6] Twentieth Ann. Rep. Bur. Am. Ethnol., p. 86.

Another mass of red contained a moderate percentage of ferric oxide with quartz and clay, forming a light red. Doubtless admixture of white clay with the red oxide formed the various shades of cream and of pink used in decorating the pottery.

The white masses from the several localities are almost pure kaolin and doubtless are the same as the white material used on the vessels.

The Tarahumare Indians of Mexico use a white earth in the decoration of pottery,[1] and Pueblo Indians of southwestern United States used kaolin on their ware.[2]

The black coloring matter occasionally found on the vessels of the lower Arkansas, seems to be hardly more than a stain, and does not lie on the vessels in a coating as do the ferric oxide and the clay. We have not been able to obtain enough of this material to make an analysis.

The painted decoration, which is almost invariably on yellow or yellow-red ware, offers but little variety. In a majority of cases we find a solid coating of red, sometimes rich in shade and carefully polished.

When designs are attempted, there is great repetition. Of the fifteen bottles found by us on the Arkansas river, decorated in red and white, but four have designs other than almost exactly similar partly-interlocked scrolls; and two of these four have scroll-decoration nearly related to that of the majority of the bottles. The contrast between the monotony of design on the painted vessels of this region and the great variety on those of southwestern United States is marked indeed.

In the case of at least some of the bottles from the lower Arkansas, with decoration of white and of red pigment, it seems as if first of all a slip, or coating, of red had been placed over the entire bottle, and that the white of the painted design had been laid on top of the red. In places, also, to define the design, the red has been scraped away, leaving the yellow of the ware in which, however, traces of the red slip still remain.

The decoration on the dark ware of the lower Arkansas has been conferred, as a rule, by means of a method explained by Professor Holmes, that is, by trailing a broad point along the clay before firing.

The incised design, properly speaking, is rarely found and is seldom other than of inferior execution, while engraved decoration, made with a fine point, is more unusual still. Several excellent examples of these forms were met with by us, however.

Of the trailed decoration we can say, as we have said of the painted designs, that there is great repetition. Some idea of the extent to which this repetition was carried may be gathered from the fact that in one cemetery on the Arkansas we found thirty-two bottles and bowls, all bearing very closely related scroll-designs formed by combinations of trailed, broad lines.

[1] Carl Lumholtz, "Unknown Mexico," Vol. I, p. 243.

[2] Walter Hough, "Archæological Field Work in Northeastern Arizona." Smithsonian Report, 1901, p. 315.

As most of the ware found by us was broken when discovered, or received injury from the spades of the diggers, it has been necessary to cement the parts together and occasionally to make slight restorations. In this latter event, however, care has been taken to introduce nothing not thoroughly justified by the remainder of the vessel, and to use for restoration a material slightly differing in shade from the color of the ware, that the modern work may not be confused with that of the aboriginal potter.

All reductions in size of vessels, and of all other objects, figured in this report, are linear; measurements are approximate. Decoration shown in diagram is as exact as to size as is possible in the case of a curved design represented on a flat surface.

Thanks are tendered to Dr. M. G. Miller, who has accompanied us on all our archæological expeditions, in charge of the anatomical portion of the work; to Mr. F. W. Hodge for literary revision of this report; and to Mr. Arthur W. Clime, who lent us efficient aid as assistant throughout the season of 1907–08.

We shall now describe our work on the lower Arkansas river, omitting many places where our quest was unsuccessful, and detailing only such as yielded tangible results.

MOUNDS AND SITES INVESTIGATED.

Near Menard Mound, Arkansas County.
Near Sawyer's Landing, Arkansas County.
Near Old River Landing, Arkansas County.
Mound near Goldman Field, Jefferson County.
Mound near Douglas, Lincoln County.
Cemetery near Greer, Jefferson County.

Near Menard Mound, Arkansas County.

The Menard mound[1] is about one mile WNW. from Menard Landing on the Arkansas river, and six miles, approximately, in an ESE. direction from Arkansas Post.

The mound is on property of Mr. J. Menard, who lives within fifty yards of its base, and who owns much land in the neighborhood, all which was placed at our disposal in the most cordial manner, as was much adjacent property belonging to Messrs. C. W. Wallace, A. L. Plant, and N. B. Menard—Mr. Wallace even allowing us to work for days in ground which had recently been plowed.

The high ground on which the mound is built, and much adjacent land, is not subject to overflow, to which so much of this region is exposed, and hence must have been the seat of a considerable aboriginal population, as it is about the first high land encountered in ascending the river.

[1] In relation to the Menard mound, see: W. H. Holmes, "Pottery from Arkansas," Third Ann. Rep. Bur. Am. Ethnol., p. 476, *et seq.*; and, Cyrus Thomas, "Mound Explorations," Twelfth Ann. Rep. Bur. Am. Ethnol., p. 229 *et seq.*

The mound, a truncated cone, imposing in appearance, is 34.5 feet in height, measured from the north, where the surrounding territory is somewhat high; measured from the northwest, where there is a depression, the height of the mound is from 3 to 4 feet greater.

The basal diameter of the mound is 167 feet; the diameter of the summit plateau is 28 feet. On the southwest is a causeway of considerable size.

It is not in the mound, however, though some digging has deen done into it in the past, that the burials and accompanying artifacts, which have made the place famous, have been found, but in small rises of the ground in the adjacent land—dwelling-sites—and even in perfectly level ground. In all directions on the surrounding territory lie bits of pottery and fragments of human bones; in the fields; in the gardens; by the roadside; everywhere, in fact; and there is no inhabitant of the neighborhood but has exact details to give, based on personal experience, of the finding of quantities of aboriginal pottery.

Unfortunately for late comers, like ourselves, the constant wash of rain over soil loosened by cultivation had laid bare a majority of the burials, or so removed the soil above them that the plow had wrought sad havoc among bones and pottery; while desultory digging also had levied a considerable toll. In consequence, only gleanings remained for us from a former abundant harvest.

Our work near the Menard mound, with from eleven to thirteen men to dig, lasted twelve working days and began in the neighborhood of the Menard home, where the curious spectacle was presented of the unearthing by us of a number of burials, with accompanying vessels of earthenware, in Mr. Menard's "front yard," between his veranda and the garden fence.

Our investigations continued over the Menard orchard and fields; were carried on for a number of days in the dwelling-sites of Mr. Wallace's fields and woods, situated in a northeasterly direction from the mound; were extended to the field of Mr. Plant, somewhat farther in the same direction, and to the woods of Mr. N. Menard.

Our work in all the woods, however, was without success, so far as the discovery of pottery is concerned, though small mounds and rises of the ground are present in them in abundance.

One hundred and sixty burials were met with during our work near the Menard mound.

The bones varied somewhat as to condition, some being badly decayed, while in other cases long-bones were recovered entire.

Some of the bones showed the effects of inflammatory conditions; one instance of anchylosis of the radio-ulnar articulation was found; and also a reunited fracture of a radius and an ulna. The two latter specimens were sent to the United States Army Medical Museum, Washington, D. C.

Certain crania from this place were preserved, and in common with all crania found by us along the Arkansas river, are described by Dr. Hrdlička in a report which, as we have said, forms the concluding portion of this part of our report.

Many fragments of crania, of considerable size, were found, some showing marks of post-natal compression and some evidently being parts of normal skulls.

No fixed orientation as to the head was noted in the burials found, skeletons having been interred with the skulls pointing in all directions.

The forms of burial were as follows:

Full length on back, 31.[1]
Closely flexed, lying on the right side, 5.
Closely flexed, lying on the left side, 4.
Closely flexed, face down, 1.
Partly flexed, lying on the right side, 17.
Partly flexed, lying on the left side, 5.
On back, the limbs widely separated, 1.
Full length on back, feet crossed, 1.
Trunk on back, knees slightly flexed to the right, 1.
Bunched burials, 39.[2]
Bunches or aboriginal disturbances, 2.
Disturbances, modern and aboriginal, 18.
Layers of bones, 2.
Children, bones often too decayed for determination of position, 23.
Badly decayed adult bones, 2.
Incompletely described in field-notes, 6.
Particularly described, 2.

The two burials to be particularly described are as follows:

Burial No. 12 was the skeleton of an adolescent, fifteen inches down, head NW., trunk on the back, the lower extremities turned to the left and slightly flexed, the legs being drawn tightly against the thighs.

Burial No. 108, fourteen inches below the surface, was a skeleton of an adult, with parts detached, yet not exactly a bunch.

We shall now describe in detail certain burials which are included in the foregoing list, to introduce the association of artifacts. All individual skeletons not otherwise defined were those of adults.

Burial No. 9, sixteen inches down, consisted of a bunch of children's bones, including three skulls. Near one skull were nine fresh-water, univalve shells, kindly identified by Dr. H. A. Pilsbry as *Viviparus subpurpureus*, the upper portions cut off to allow the use of the shells as beads.

Burial No. 10, eighteen inches deep (all depths are taken to the upper surface of the burials), consisted of a mass of bones in a grave distinctly traceable from the surface down.

These bones, an ideal example of the bunched form of burial (Fig. 1), lay in a symmetrical pile, the long-bones parallel, the smaller bones stowed away here and there between them.

[1] Two children lying side by side in one grave are included as a single burial.
[2] One consisting of bones of three children. Some bunches had two, three, four, five, and two had seven skulls each.

At one end of the pile were three skulls; two of these, one of an adult, and one of a child, lay side by side on the base of the grave with the skull of a child upon them. Immediately behind these skulls, in among the long-bones, was the skull of another child.

This bunched burial lay ENE. and WSW., the skulls being at the eastern end.

The dimensions of the pile, which apparently included a full complement of bones for four skeletons, were: length, 29 inches; breadth, 15 inches; height, 7 inches.

FIG. 1.—Burial No. 10, a bunched burial. Near Menard Mound.

Near the bunch lay an undecorated bowl of earthenware.

The adult skull from this burial, showing cranial compression, is one of those sent by us to the National Museum.

Burial No. 13 was a great layer of mingled bones representing a number of skeletons and covering a considerable area. With this burial were the bases of several bowls or bottles, the upper parts of which had been plowed away, and a

number of bone pins, some with carved heads, lying parallel one to another in a heap (Fig. 2).

Burial No. 46, a skeleton lying partly flexed on the right side, had, near the skull, a water-bottle and a vessel of a conventionalized shell-form, this latter vessel lying inverted over a mass of kaolin—white clay used by the aborigines for paint. Glass beads were near the skull.

Burial No. 48, closely flexed on the right side, had, at the skull, a bottle and two inverted bowls, in one of which latter was a musselshell.

At the chin of the skull were four pebbles, one pebble-hammer, and a mass of kaolin.

Burial No. 69, two feet down, was a bunched burial, very symmetrically arranged, the long-bones parallel, smaller bones stowed in between, the presence of fifteen humeri showing that the remains of at least eight individuals were represented in the burial. Though a number of lower jaws were present, only a single fragment of any other cranial part was found.

Burial No. 73 was the remains of a skeleton of a child, with an undecorated bowl and Vessel No. 103, a fine, polished effigy bottle of black ware (Fig. 16), representing a seated child with chubby legs extended, no doubt the property of the child when alive.

Burial No. 78, an interesting bunched burial, similar to several found by us near the Menard mound, consisted of a little pit with a lot of long-bones carefully put in perpendicularly, and surmounted by a skull. Near the skull were two vessels, one on its side and in contact with the bones.

Burial No. 160, partly flexed on the right side, had shell beads at the neck; a water-bottle near the skull; and near the bottle a mass of red pigment, to which allusion has already been made, and which Dr. H. F. Keller has determined to be a mixture of clay and oxide of iron, with a not very high percentage of the latter.

There were found near the Menard mound, glass beads with four burials; brass beads or small ornaments of brass, with five burials; and copper beads with one burial.

In one instance, a small mass of iron, badly rusted, lay with brass; and once small ornaments were so badly decayed that it was impossible to determine whether they were of brass or of copper.

Under the skull of a skeleton lay a small stone hatchet, and several hatchets (one of hornstone having an extremely sharp cutting edge) were found apart from human remains in the midden debris where most of the burials were. A gracefully-made hatchet of fair size, from the Wallace field, was given by us to Mr. Wallace, without determining the stone of which it is made.

Small quantities of shell beads lay with several burials.

With a burial was a tooth kindly identified by Prof. F. A. Lucas as the right upper incisor of a beaver. We are also indebted to Professor Lucas for identification of other material from dwelling-sites in the neighborhood of the Menard mound, as follows: a single canine tooth and the lower jaw of a black bear; part of the

FIG. 2.—Bone pins with Burial No. 13. Near Menard Mound. (Full size.)

skull of a Virginia deer, which "had been very neatly opened to extract the brains"; "parts of the right humerus and right radius of a bull buffalo, both from the same animal."

There were many bison bones in the Wallace field, some of considerable size.

Apart from burials were found: an awl of bone; tines of deer antlers, neatly severed from the horn by a cutting tool; a tubular bead of earthenware, 1.5 inches long, .5 inch thick; several pottery discs; several stone discs, none more than 3 inches in diameter; a large pebble worked into the form of a barrel, with a neatly drilled hole at one end, .6 of an inch in diameter and somewhat more than .5 of an inch in depth, with a considerable core remaining at the base; numerous rude arrowheads and knives, of chert; small cutting implements of the same material; and a number of chisels, each several inches in length, wrought from pebbles and having the original surface of the pebble still remaining in part.

A flat pebble about one inch in diameter was picked up on the surface; another pebble having a length of about two inches was found with the skeleton of a child. Both are shown in Fig. 3.

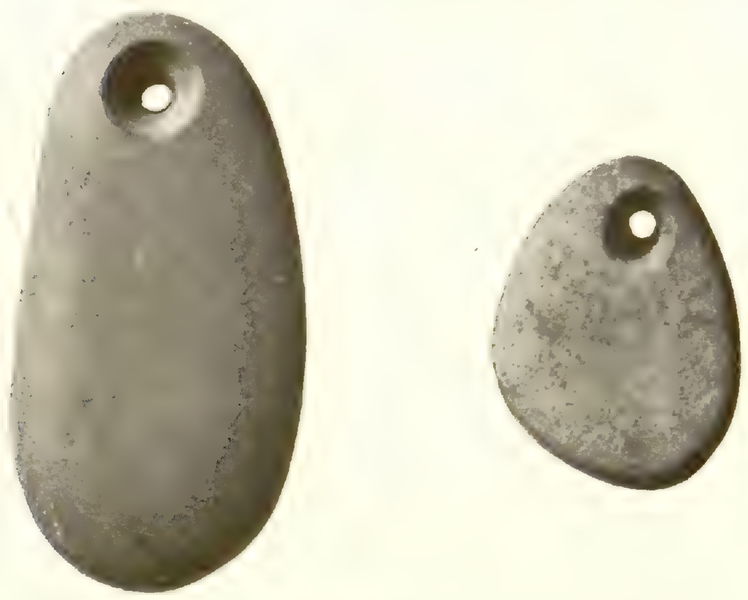


FIG. 3.—Perforated pebbles, near Menard Mound. (Full size.)

In the Wallace field was found a fragment of a conglomerate rock of high specific gravity, polished on both sides. Judging by the curvature of its inner and outer surfaces, it is evidently part of a large vessel.

We know the aborigines who inhabited the vicinity of the Menard mound were carvers of stone of no mean ability, as it was on the farm of Mr. W. N. Almond, about two miles from the mound, that Mr. Almond plowed up the two stone pipes and the beautiful ceremonial palette of stone shown in "The American Antiquarian"[1] and subsequently referred to by Professor Holmes[2] in an instructive paper.

We visited Mr. Almond and, with his permission, dug where the disc had been found, but without result.

The palette and pipes are now owned by Mr. H. L. Stoddard, of Stuttgart, Ark.

From a low mound in the Wallace field came a quartz crystal bearing no groove for suspension. Father Le Petit,[3] speaking of the Natchez Indians, describes their idols as figures of stone or of baked clay; also bones of big fish and bits of crystal; and Father Gravier[4] tells of a bit of crystal in the Natchez temple.

At the present time many and beautiful specimens of quartz crystals come from the Hot Springs, Ark.

[1] May and June, 1904, pp. 154, 155.
[2] "Certain Notched or Scallopped Stone Tablets of the Moundbuilders," Amer. Anthropologist, Jan.-March, 1906.
[3] French, Hist. Coll. of La., Part III, p. 141.
[4] French, Hist. Coll. of La. and Fla., 1875, p. 82.

Also in midden refuse was part of a bowl of a rude pipe of earthenware. Professor Holmes, speaking of the earthenware pipes of the region of which the Arkansas valley forms part, truly says:[1] "In the central and southwestern sections pipes were for the most part remarkably rude and without grace of outline, and generally without embellishment, while the earthenware of the same territory was well made and exhibits pronounced indications of esthetic appreciation on the part of the potters."

Two hundred and fourteen vessels of earthenware, mostly undecorated and of ordinary form, came from the neighborhood of the Menard mound. In this number we include all vessels, broken and whole, and fragments large enough to show that a vessel had been interred.

While some burials were without accompanying pottery, the majority of interments had a mortuary tribute of this kind, especially in the Menard place in the vicinity of the mound, and in Mr. Wallace's field.

On the other hand, the few burials found by us in the woods, and a fair number of skeletons in Mr. Plant's field, were without artifacts of any sort.

As a general rule, vessels lay near the heads of burials and were usually single or a pair. In exceptional cases vessels were found by us at other parts of the skeletons, and on one occasion so many as ten were found with a single burial.

More fully to illustrate certain of these exceptional cases, we shall describe some of the noteworthy burials in detail.

Burial No. 62, bones of a child, had at the skull two bowls of moderate size, one inverted; a small bottle, and a diminutive saucer placed on its edge.

Burial No. 83, the skull of a child from which the remaining bones probably had disappeared through decay, had around it no fewer than ten vessels, comprising two nests of three each and four vessels placed singly, the skull being entirely surrounded.

Burial No. 98, a skeleton lying partly flexed on the right side, had near the pelvis, and also near the feet, which drawn back, approached the pelvis, an inverted bowl more or less covering two small, inverted bowls, side by side, which were lying on a fourth bowl, also inverted. In contact with this mass of pottery was a small bowl tilted on its side.

Incidentally, we may say that decayed shell beads were at the neck of the skeleton, and a knife wrought from a chert pebble lay near the skull.

Burial No. 150 consisted of a bunch of bones with three skulls, one of them being that of a child. Crushed against one skull was an inverted bowl, and nearby were a teapot-shaped vessel, in fragments, and a bowl.

Near the child's skull were two small water-bottles, while the other adult skull had near it a vessel of eccentric form.

The crania in this bunch lay separated one from another, the child's skull being on top, one adult's skull at one end, and the remaining skull somewhat at the side.

[1] "Aboriginal Pottery of Eastern United States," Twentieth Ann. Rep. Bur. Am. Ethnol., p. 98.

We shall now describe in detail the more noteworthy vessels from the neighborhood of the Menard mound.

Vessel No. 34. This beautiful bottle (Plate XIII) is one of the very few vessels found by us on the lower Arkansas river showing in two colors a design other than the scroll. The ware is light yellow. The body is globular, but projects somewhat at the base, which is flattened. The long, graceful neck, flaring toward the aperture, is coated with pigment, brick-red in color. Around the body are spaces of the yellow ware, defined by white pigment. These spaces, circular on top, with extensions tapering downward, have precisely the shape of the copper pendants found by us in the great prehistoric site at Moundville, Ala., the circular portions of which contain either swastikas or stars. On this vessel similar spaces enclose five-pointed stars on the upper row, and figures somewhat resembling an arrowhead on the lower tier. All these stars and projectile points (if that is what the latter represent) are colored with brick-red pigment.

The star does not seem to have been extensively employed on the ware of the middle Mississippi region. An example, however, is described as coming from southern Missouri.[1]

Vessel No. 170 is a bottle of yellow ware, 4.7 inches in height, with red pigment exteriorly on the neck. The decoration on the body consists of four irregular circles of solid color, red and white alternately. Each of these circles is surrounded by a circular space without paint, showing yellow ware, which space is, in turn, enclosed in a painted circle, white around the red and red around the white The same style of decoration may be seen on the small "teapot" vessel in Plate XX.

Vessel No. 194, of dark ware (Fig. 4), is of the "teapot" variety which, as we have said in our introductory remarks, is found only in eastern Arkansas or in nearby regions.

It seems to us there is a possibility that this type of vessel may be derived from the gourd, although vessels that unmistakably represent the gourd usually have a small depression opposite the neck, or extended part, though such is not invariably the case, as we have seen a few examples in which the knob and not the depression is present. In Fig. 5 is shown a gourd-vessel from southern Missouri,[2] which, were the upper part of the neck cut away and a smaller aperture present on the top, could well be a vessel of the "teapot" class.

Vessel No. 78 is a toy-vessel of dark ware, of the "teapot" variety (Fig. 6), the smallest of this kind found by us along the Arkansas river. The spout and part of the opening have been restored.

Vessel No. 64 also belongs to the "teapot" variety, and is 7.6 inches in height. The vessel has a uniform coating of red pigment, which is well preserved and gives the vessel a rich and striking appearance.

Vessel No. 166 is another of the "teapot" form, coated with red pigment. Its height is 3 inches, a size evidently fitting it for a child's use. In this particular

[1] Dr. Edward Evers, "Archæology of Missouri," Part I, Pl. IV, Fig. 1.
[2] Evers, *op. cit.*, Pl. XIV, No. 228.

CERTAIN MOUNDS OF ARKANSAS AND OF MISSISSIPPI.

NEAR MENARD MOUND, VESSEL NO. 34. (HEIGHT, 9.6 INCHES.)

FIG. 4.—Vessel No. 194, of the "teapot" variety. Near Menard Mound. (Height 6.25 inches.)

FIG. 5.—A gourd-vessel from Missouri. (Four-fifths size.)

FIG. 6.—Vessel No. 78. Near Menard Mound. (Full size.)

instance there was a group of five vessels, mostly small, with no human remains visibly in association. Presumably the skeleton of an infant had disappeared through decay.

Vessel No. 82 is another of the "teapots," 3.8 inches in height, with a coating of red pigment, somewhat worn in places. In relief on two opposite sides are modeled the legs of a frog. The head, which has been on that part of the vessel opposite the spout, is missing through breakage in aboriginal times. We shall figure in its proper place a more complete frog-"teapot" from another site. (See Plate XVI.)

FIG. 7.—Vessel No. 91. Near Menard Mound. (Diameter of bowl 7.5 inches.)

Vessel No. 91, of dark ware, is a life-form representing a quadruped, the legs being used as supports for the vessel. On one side is a small head which does not aid us in determining the animal represented, while on the opposite side is a tail turned downward. The decoration, made with a broad, trailing point, is of the scroll variety (Fig. 7).

Vessel No. 50 is a graceful bottle of yellow ware, with a neck first contracting, then flaring. The decoration consists of a coating of red pigment on the neck and, on the body, partly interlocked scrolls in red and white, as shown in Plate XIV.

CERTAIN MOUNDS OF ARKANSAS AND OF MISSISSIPPI.
NEAR MENARD MOUND, VESSEL NO. 50. (HEIGHT, 9.5 INCHES.)

CERTAIN MOUNDS OF ARKANSAS AND OF MISSISSIPPI.
NEAR MENARD MOUND, VESSEL NO. 133. (FULL SIZE.)

COCKAYNE, BOSTON.

So many vessels of this type and style of decoration were found by us along the Arkansas river that we shall not describe particularly any other than this one.

Vessel No. 38. This graceful vessel, shown in Fig. 8, is of black ware, and has an evenly made decoration of trailed, broad lines, which is precisely similar to one shown by Professor Holmes[1] and described as coming from the lower Mississippi region.

Vessel No. 65 is a bottle of dark ware, ellipsoidal in shape, bearing on one side, partly incised and partly in relief, the head perhaps of a quadruped or possibly of a fish. On the opposite side appears an upraised tail. The eyes are distinctly aboriginal in execution (Fig. 9).

FIG. 8.—Vessel No. 38. Near Menard Mound. (Diameter 7.3 inches.)

An almost exact counterpart of this vessel, which also came from near the Menard mound, is twice figured by Professor Holmes.[2]

Vessel No. 133 is a bottle of yellow ware, well coated with red pigment, and represents a deep-bodied fish similar to the sunfish. The head and tail project from the body of the vessel as do ventral and dorsal fins (Plate XV). In the plate the neck of the vessel, which is 1.6 inches in length, of necessity appears somewhat foreshortened. The aperture is slightly exaggerated in size owing to its prox-

[1] "Aboriginal Pottery of the Eastern United States," Twentieth Ann. Rep. Bur. Am. Ethnol., Pls. LId and LIIIb.

[2] Third Ann. Rep. Bur. Am. Ethnol., p. 482. Twentieth Ann. Rep. Bur. Am. Ethnol., Pl. XXIIId.

imity to the camera in the initial process of preparation of the plate. Around the neck is considerable abrasion, as by the use of a cord for suspension.

Vessel No. 185 is a bottle of yellow ware, 5.3 inches high, also a life-form representing a fish not unlike the one just described. Much of its original coating of red paint has been worn away.

FIG. 9.—Vessel No. 65. Near Menard Mound. (Height 5.6 inches.)

Vessel No. 61 is a bottle of rather coarse, yellow ware, the body ovoid with flattened base. The incised decoration, rather roughly executed, consists of a meander surrounding circles (Fig. 10).

Vessel No. 30 is a wide-mouthed water-bottle or jar, of dark and rather porous ware. The decoration, which is of broad, trailed lines, is a volute design five times shown (Fig. 11).

Vessel No. 36 is a graceful bottle of dark ware, having a design of which the scroll forms part, conferred by imprints of a blunt-pointed implement, as shown in Fig. 12.

Vessel No. 62 is an undecorated bottle of dark, porous ware, shown in Fig. 13.

Vessel No. 31 is a wide-mouthed bottle or jar, of dark ware, having a hemispherical body on which is a meander decoration consisting of three parallel bands of punctate markings enclosed within parallel lines (Fig. 14). In addition, on the base is a design represented in Fig. 15.

FIG. 10.—Vessel No. 61. Near Menard Mound. (Height 9.9 inches.)

Vessel No. 102 (Figs. 16, 17) is a human effigy-vessel of hard, dark ware, to which reference has been made in an earlier part of this report. This life-form represents a child with its plump legs extended, and doubtless has been the property of the little one with whose remains it was found.

Vessel No. 88 is a pot of yellow ware, with a design in which the scroll conferred by a broad-pointed tool trailed over the surface, figures in combination with punctate markings (Fig. 18).

FIG. 11.—Vessel No. 30. Near Menard Mound. (Height 7.3 inches.)

FIG. 12.—Vessel No. 36. Near Menard Mound. (Height 9.7 inches.)

FIG. 15.—Vessel No. 31. Decoration of base.

Vessel No. 35, of dark ware, 6.7 inches in height, with a circular opening at the top. near which is a small knob, is intended to represent a gourd. An almost exactly similar vessel from Arkansas is figured by Professor Holmes.[1]

FIG. 13.—Vessel No. 62. Near Menard Mound. (Height 7.2 inches.)

Vessel No. 208, a vase of gray, porous ware, light in weight, with base resembling a much truncated cone reversed (Fig. 19), has an interesting incised decoration around the body (Fig. 20), sug gestive of the bird-head motive.

Vessel No. 200 is a vase of gray, porous ware, of somewhat unusual form, without decoration (Fig. 21).

Vessel No. 55. We have here a bowl of yellow ware (Fig. 22), with an interior coating of red paint and a band of red pigment below the margin on the outside, such as is usually found on vessels of this character along the lower Arkansas river. On one side is a rudely modeled human head with high crest, looking outward; on the other side, the conventional tail—both head and tail having a coating of red pigment.

Vessel No. 114 (Fig. 23) differs from the one just described in minor details only.

Vessel No. 174 is a bowl of coarse, yellow

FIG. 14.—Vessel No. 31. Near Menard Mound. (Diameter 7.4 inches.)

[1] Twentieth Ann. Rep. Bur. Am. Ethnol., Pl. XIXf.

FIG. 16.—Vessel No. 102. Near Menard Mound. (Height 6.8 inches.)

FIG. 17.—Vessel No. 102. Side view.

FIG. 18.—Vessel No. 88. Near Menard Mound. (Diameter 4.5 inches.)

FIG. 19.—Vessel No. 208. Near Menard Mound. (Diameter 6.3 inches.)

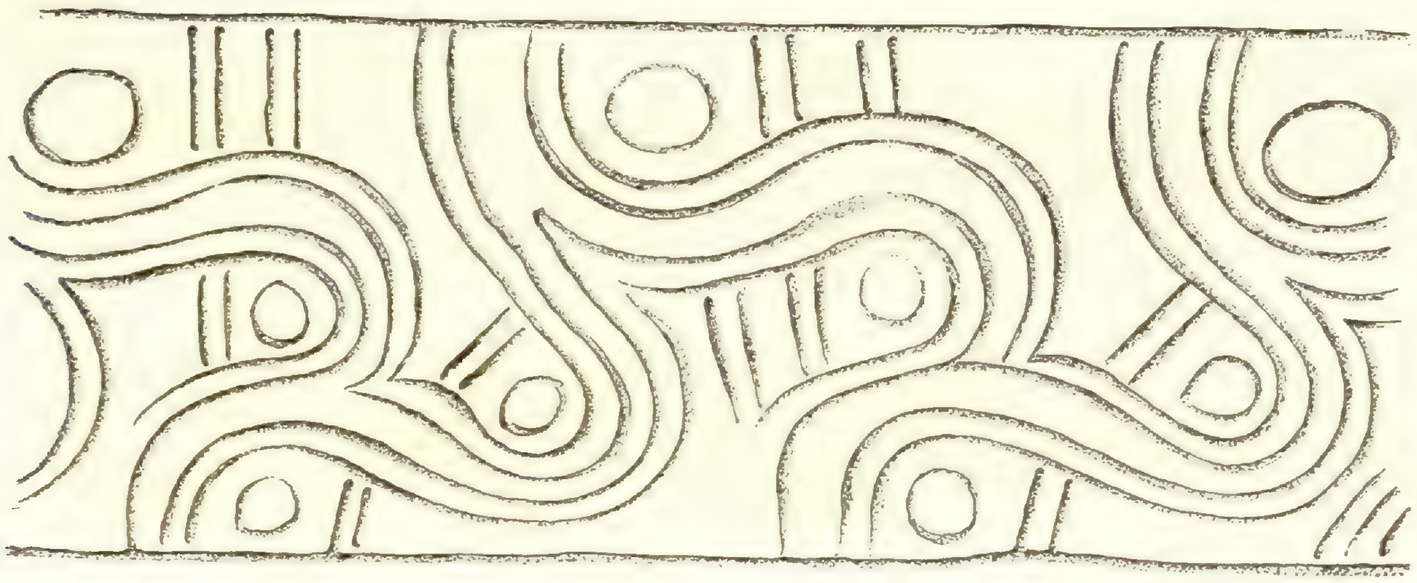


FIG. 20.—Vessel No. 208. Decoration. (Half size.)

FIG. 21.—Vessel No. 200. Near Menard Mound. (Diameter 4.9 inches.)

FIG. 22.—Vessel No. 55. Near Menard Mound. (Diameter 6.5 inches.)

ware (Fig. 24) with pigment decoration, having the head of a bird modeled on one side and conventional tail on the opposite side.

Vessel No. 171, a bowl of yellow ware, having on each side, marginally, a

FIG. 23.—Vessel No. 114. Near Menard Mound. (Diameter 8.1 inches.)

band of red pigment, and in the lower part of the interior, shown in red pigment, the circle and cross, *i.e.*, the symbol of the sun and the four winds, or directions (Fig. 25).

FIG. 24.—Vessel No. 174. Near Menard Mound. (Diameter 10 inches.)

Joutel[1] (1687) tells in a most interesting way how the Cenis (Hasinai, or Caddo) Indians of Texas, in celebrating a successful battle, held out scalps toward the four directions.

Vessel No. 139 is a bowl (Fig. 26) similar to the one just described, with the addition of equidistant, festooned bands of red pigment between the arms of the cross. These semicircles probably represent (a part for the whole) entire circles, or sun symbols.[2]

FIG. 25.—Vessel No. 171. Near Menard Mound. (Diameter 7 inches.)

NEAR SAWYER'S LANDING, ARKANSAS COUNTY.

Sawyer's Landing is five miles, approximately, by water, below Arkansas Post, on the same side of the river.

About one mile in a southeasterly direction from the landing is the home of a colored family named Johnson, in front of whose doorway is a small mound in which our search was not rewarded.

[1] French, Hist. Coll. of La., Part I, p. 161.

[2] Charles C. Willoughby, "An Analysis of the Decorations upon Pottery from the Mississippi Valley," Journ. Am. Folk-Lore, Vol. X, 1897, p. 13.

A large field adjacent to the Johnson property, which had been under cultivation but was fallow at the time of our visit, was placed at our disposal by Messrs. Pettit and Pettit, of Stuttgart, Ark., to whom the warm thanks of the Academy are tendered.

On the surface we found a brass disc about 1.5 inches in diameter, with a central perforation. Analysis by Doctor Keller showed the disc to be of very impure brass, containing, besides copper and zinc, very considerable amounts of lead and iron, as well as traces of arsenic and silver.

FIG. 26.—Vessel No. 139. Near Menard Mound. (Diameter 6.5 inches.)

We devoted part of a forenoon to this field, sinking holes here and there, with the result that seven burials were met with, all near together, in the highest part of the field.

Six of these burials certainly were of the bunched variety, one containing bones belonging to at least two skeletons. The remaining burial—probably a bunch also—had been disturbed by recent cultivation.

No bones were in a condition to save.

Twelve vessels were found in connection with these burials, many crushed and

some broken by the plow. Some burials were without artifacts, while as many as four vessels lay with one interment, a water-bottle having been placed on top of three small, shallow bowls, arranged one above the other.

Vessel No. 5, of yellow ware, is a bowl with a bird's head on one side, and a conventional tail on the other. The only point of interest about this vessel is that the crest of the bird is represented by excisions, an unusual method (Fig. 27).

Vessel No. 7 is a small bowl with the head of a frog extending forward from it, and fore-legs and hind-legs modeled in relief.

FIG. 27.—Vessel No. 5. Near Sawyer's Landing. (Diameter 8.75 inches.)

The aboriginal artist has not been trammeled by details, as the fore-feet of the frog are represented with three toes each and the hind-feet each with four toes —one too few in each case, as the reader is doubtless aware.

NEAR OLD RIVER LANDING, ARKANSAS COUNTY.

Old river (a former course of the Arkansas) is about 3.5 miles above Arkansas Post, following the river, on the same side.

By landing at the lower side of the lower mouth of Old river and following a road parallel to it, about 1.5 miles, we reached the property of Mr. H. S. Jones, of Arkansas Post, to whom we are greatly indebted for cordial permission to investigate whatever portion we saw fit.

Near the road, forming part of Mr. Jones' property is a field (twelve acres in extent, we are informed), at the eastern corner of which rises a mound about 5 feet in height and 75 feet, approximately, across its somewhat irregular base, except where a small part of the mound is cut away by a cross-road, where the diameter is, of course, somewhat less.

Part of the mound, not being on Mr. Jones' property, was not dug into by us. The part investigated yielded nothing except the neckless body of a water-bottle, that probably got in with the clay material of which the mound is made.

The history of the twelve-acre field and of an unenclosed field on the other side of the cross-road, which latter field has now been so denuded of soil by heavy wash of rain after cultivation that careful investigation by us was without result, is a long list of discoveries of earthenware vessels, by all who have had a hand in the cultivation of the property.

In the twelve-acre field, which is higher than most of the surrounding land and is not subject to overflow, and in the adjacent barnyard of Mr. L. F. Shepherd, the manager of the property, are a number of circular rises of the ground, all dwelling-sites from which, with the exception of those in the barnyard, which have not been under cultivation, the plow had turned out much clay, hard and red from ancient fires.

Two of these dwelling-sites (those nearest the mound) were each about 40 feet in diameter, the others somewhat less.

The sites, nine in all, were carefully dug by us and nearly all found to contain burials and artifacts, but to a very different extent.

About 30 yards W. by N. from the mound was one of the larger elevations which had been long and deeply plowed over and doubtless deprived of much of its original contents, many of the burials being but 6 inches below the surface—the upper parts of the most deeply buried being but 18 inches down.

From this site came thirty burials, thirty-four additional being found in the other dwelling-sites which had been less deeply plowed and consequently in which bones and artifacts were in somewhat better condition.

All bones, however, were badly affected by decay; no crania were saved, but large fragments of some showed moderate artificial cranial compression.

As the forms of burial in these dwelling-sites near Old River Landing presented nothing markedly different from those met with near the Menard mound, they will not be described, although exact details are given in our field-notes.

In one dwelling-site were found several burials which we could not positively assign to either the flexed burial or to the bunched method of interment. These particular burials, each made up of the parts of one skeleton only, had the bones largely in place; a few, however, were in disorder. Presumably these latter bones,

having become detached in the dead-house or on their way to the place of burial, were piled in indiscriminately at the time of interment.

The yield of artifacts other than pottery, was meager indeed.

With a bunched burial was a diminutive pipe of limestone, so water-soaked that parts fell from it on removal.

Near the skull of a bunched burial was a quartz crystal showing no sign of workmanship.

Burial No. 17, consisting of what was left by decay of the skeleton of an infant or of a very young child, had with it, in addition to two earthenware vessels, seven cones of sheet-brass, from two to three inches in height; a number of blue glass beads; and fifteen very roughly-made shell beads, from .4 of an inch to somewhat more than 1 inch in length. The shell beads are about as rough in appearance as any we have met with in all our experience, being little more than perforated fragments of shell.

Burial No. 27, a skeleton of an adult, partly flexed, lying on the left side, besides having two vessels of earthenware near the skull and upper part of the trunk, had near the neck six shell beads, or rather six rough sections of shell that had been made to do duty as beads, one of which is shown in Fig. 28.

With another burial having vessels in association were beads of blue glass.

Burial No. 65, the skeleton of an adult, lying partly flexed on the right side, had with it, in addition to two vessels, two small "celts" lying together between the vessels and the skull. We have not thought it worth while to mutilate these "celts" for microscopic slides and for material for analysis, to determine the stone or stones of which they are made, and deem it useless to hazard a guess on the subject.

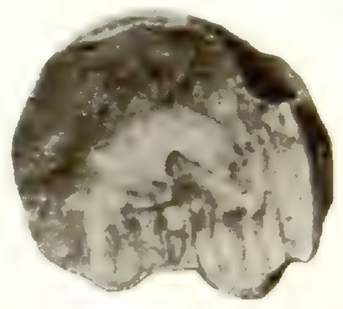


FIG. 28.—Shell bead. Old River Landing. (Full size.)

Another small "celt" of hornstone, like one found near the Menard mound, is remarkable for the sharpness of its edge.

In debris of the dwelling-sites were several small chisels wrought from pebbles of chert; one or two diminutive "celts"; and a canine tooth identified by Professor Lucas as having belonged to a black bear.

From the surface of the two fields to which reference has been made, but doubtless in many cases plowed or washed from dwelling-sites now, or formerly, on these fields, came neatly-made arrowheads of chert; small chisels of chipped chert; diminutive cutting-tools of like material; and two flat pebbles perforated for suspension, similar to those from near the Menard mound.

Associated with the thirty burials encountered in the dwelling-site we have referred to, were forty-nine vessels of earthenware—many, however, crushed and broken.

In all the sites examined eighty-two vessels lay with the sixty-four burials, if we include several vessels not immediately with interments, but which doubtless had been separated from them by the plow.

The pottery of the Old River dwelling-sites, as a rule, lay near the skull, but, as usual, there were exceptions.

Much of the ware was inferior in quality and friable to the last degree after its long exposure to continual soaking with water.

FIG. 29.—Vessel No. 1. Old River Landing. (Height 8 inches.)

As a rule, the vessels met with presented no novelty in form, and were mainly pots, bowls, and bottles.

Many of the vessels are undecorated. Pigment is the principal form of decoration employed—red, or white and red in combination. Exceptionally, black coloring-material, now hardly more than a stain had been used.

One feature connected with this place was new in our experience. Nearly all

CERTAIN MOUNDS OF ARKANSAS AND OF MISSISSIPPI.
NEAR OLD RIVER LANDING, VESSEL NO. 19. (FULL SIZE.)

COCKAYNE, BOSTON.

the bowls—and a large number of the vessels found were bowls—had been placed in the ground inverted. This fact may denote that at this place at least, the bowls, when placed with the burials, did not contain offerings of food.

In some cases, one vessel had been placed within another, as, for instance, a pot resting inverted within another pot. Another vessel was found turned over a smaller one which was itself inverted.

The more noteworthy vessels will now be described in detail.

Vessel No. 19 is an interesting example of the life-form and "teapot" vessel combined. From one side projects the head of a frog, while on the opposite side is the spout (a restoration) of the "teapot." In connection with these are the legs of a frog modeled in relief (Plate XVI). The upper part of the vessel is coated with red pigment, while the lower part has been covered with white coloring-material, now largely worn away.

Professor Holmes, as we have noted in our introductory remarks, describes[1] and figures[2] an animal form "teapot" from "Mississippi." The fine specimen referred to by him differs from ours, however, in that the head is apparently not that of a frog, while the legs, instead of being modeled in relief on the vessel, extend vertically downward and serve as supports.

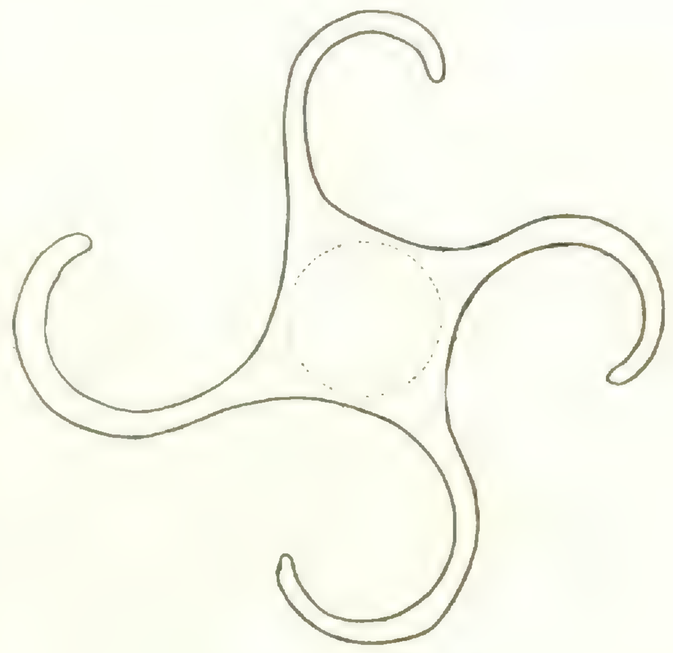


FIG. 30.—Vessel No. 1. Part of the decoration. (One-fifth size.)

Vessel No. 1. This vessel, a bottle, was found in many fragments that have since been cemented together with slight restoration of the body and almost complete restoration of the neck (Fig. 29). The ware, which is yellow, appears in but two or three spots where the painted designs, which are pink and white, are not in contact through oversight on the part of the aboriginal artist. Both varieties of pigment on this vessel have adhered exceptionally well, no flaking being apparent.

The design differs from that[3] on most of the bottles decorated in two colors, met with by us along the lower Arkansas river, and consists of a current scroll in deep pink surrounding the body of the vessel, with an encircling band of white above and below, from which four equidistant arms extend downward and upward, respectively, forming, in connection with each other, partly interlocked scrolls; at the same time the upper and the lower circles and arms form swastikas of a pattern shown in Fig. 30.

The neck of the bottle has been pink, matching the current scroll decoration,

[1] Fourth Ann. Rep. Bur. Am. Ethnol., p. 403.
[2] Twentieth Ann. Rep. Bur. Am. Ethnol., Pl. XLb.
[3] *I. e.*, partly interlinked scrolls, shown in Pl. XIV.

and a slight extension at the base of the vessel, having a flat under surface, is coated with pigment of the same shade on such parts as are visible.

It is interesting to note that two bottles bearing almost exactly similar decoration to that just described, were found in a mound in Coahoma county, Mississippi.[1]

Vessel No. 28, a gracefully formed, acorn-shaped vessel of dark, smooth ware, 4.5 inches in height, bears around the upper portion a design six times shown, con-

FIG. 31.—Vessel No. 26. Old River Landing. (Height 5.4 inches.)

sisting of partly interlocked scrolls, each having on its upper part a small, roughly triangular space filled with reticulated lines. The entire design is a conventionalized decoration derived from the representation of crested serpents on earthenware, the evolution of which we have shown[2] step by step, through the merging

[1] Charles Peabody, "Exploration of Mounds, Coahoma County, Mississippi," Peabody Museum Papers, Vol. III, No. 2, Pl. XV.

[2] "Moundville Revisited," Fig. 65 to Fig. 73, inclusive. Journal of the Academy of Natural Sciences of Philadelphia, Vol. XIII.

CERTAIN MOUNDS OF ARKANSAS AND OF MISSISSIPPI.

NEAR OLD RIVER LANDING, VESSEL NO. 45. (FULL SIZE.)

COCKAYNE, BOSTON.

of crested serpents, and interlinked, crested scrolls, down to the scroll pure and simple.

Vessel No. 26 is a bottle of dark and rather inferior ware, with double encircling lines of projections around the body (Fig. 31).

Vessel No. 52. This curious vase of porous, yellow ware, shown in three positions in Figs. 32, 33, 34, bears an incised decoration representing a face on one side of the body of the vessel, and scroll designs over the remaining portions.

FIG. 32.—Vessel No. 52. Old River Landing. (Full size.)

Vessel No. 45. This beautiful vessel, of the "teapot" variety (Plate XVII,) is of yellow ware and has a scroll design alternately deep red and pink. The neck is red, and the red and pink scrolls continue up the spout, as does a streak of black separating the other two colors. The base is black (or rather has been black,

FIG. 33.—Vessel No. 52. Side view. (Full size.)

FIG. 34.—Vessel No. 52. Back view. (Full size.)

as hardly more than a stain remains) and the color projects upward from the base between the pink pigment and the red.

Vessel No. 78 is a bowl of dark ware, representing a turtle (Fig. 35), the head, tail, and flippers projecting. Two holes on opposite sides of the vessel have served for suspension.

Vessel No. 21, a cooking-pot, has considerable soot still adhering. It bears a

FIG. 35.—Vessel No. 78. Old River Landing. (Diameter 6 inches.)

rude decoration largely made up of concentric circles, probably sun-symbols, apparently made by the imprint of coarse cord (Fig. 36).

Vessel No. 21a is a pot of yellow ware, with the curious incised decoration shown in Fig. 37. This vessel has been in use for culinary purposes, as traces of soot remain on the outside.

Vessels Nos. 9 and 27 are bowls of moderate size, each with four equidistant loop-handles below the rim, and an upper, outer, encircling band of red pigment, somewhat more than one inch in width. The interiors of both bowls have rich coatings of red pigment.

FIG. 36.—Vessel No. 21. Old River Landing. (Diameter 7.75 inches.)

FIG. 37.—Vessel No. 21a. Old River Landing. (Height 4.8 inches.)

Vessel No. 46 is a bowl (Fig. 38) with interior coating of red paint and a band of the same color, about one inch in width extending below the rim. A human head, modeled in an upright position, looks outward on one side and a conventional tail projects horizontally from the opposite side.

FIG. 38.—Vessel No. 46. Old River Landing. (Diameter 7.4 inches.)

FIG. 39.—Vessel No. 54. Old River Landing. (Diameter 7.5 inches.)

Vessel No. 54, decorated with red pigment, like the vessel just described, has the head of a bird on one side and the usual conventional tail on the other side (Fig. 39).

Vessel No. 14 is a bowl of porous, yellow ware, decorated with red paint in

the same manner as are the two last preceding vessels, and having, in place of a modeled head taken from life, a diamond-shaped figure with four perforations. The conventional tail is present (Fig. 40).

Mound near Goldman Field, Jefferson County.

Goldman field is on the bank of the Arkansas river about six miles by water below the settlement of Douglas, but on the opposite side, that is on the right-hand side, going up.

In woods subject to overflow, about one-half mile NW. by N. from Goldman field, is a mound about 4.5 feet high and 87 feet across its circular base.

Fig. 40.—Vessel No. 14. Old River Landing. (Diameter 7.2 inches.)

Thirteen holes were sunk by us in this mound, resulting in the discovery of six burials, between 8 inches and 38 inches in depth.

Three of these burials consisted of layers of fragments of calcined human bones, one layer being of considerable size, the bones representing several individuals.

With these layers were charcoal and masses of clay reddened by fire. The cremation, however, did not appear to have taken place in the mound, but elsewhere, the reddened clay and charcoal seemingly having been gathered up with the bones for their final deposit.

With one of the layers of calcined bones was a "celt" apparently of igneous rock.

Two of the burials were limited each to a badly decayed, isolated skull. With

one was an undecorated bowl; with the other, a bowl bearing rude, encircling lines, and having had, above the rim, the head of a bird or quadruped, part of which had been broken off before interment. Both bowls were of most inferior ware and in fragments.

The remaining burial was a badly decayed skeleton, closely flexed and lying on the right side.

Apart from human remains, in the mound was a rude knife wrought from cherty material.

Mound near Douglas, Lincoln County.

In the verge of woods, about two miles ESE. from Douglas, on property of Mr. R. E. Lake, of Douglas, who kindly placed it at our disposal, was a mound 6.5 feet high and 70 feet across its circular base. The summit plateau, also circular, was 22 feet in diameter.

The mound had sustained some digging in the past by treasure seekers, we were told, and, to a limited extent, on one or two occasions, by inhabitants of Douglas. This digging, however, had not affected the height of the mound or its diameter.

On the western side of the mound was a depression, filled with water at the time of our visit, whence material for the building of the mound had been taken; and a similar, though smaller, depression was on the opposite side.

After some exploratory digging, it was found that only the core of the mound contained burials, and these were superficial, the mound apparently having been originally a domiciliary one and subsequently used as a cemetery.

The core of the mound, 44 feet in diameter, was dug out by us, at first along the base, then a little above it, until a portion 16 feet in diameter remained. This part was dug out to a depth of 3 feet, as no burials had been met with deeper than 31 inches.

Thirty-two burials were encountered, all proving to be of the bunched variety, wherever determination was possible. Those not classified were disturbances in some cases; in others, where many bones seemed to have disappeared through decay. Several also were bones of children, much crushed and disintegrated.

No skull was found in condition to save or, with one exception, in fragments large enough to enable determination as to cranial compression. In this one case, no compression was apparent.

A pathological specimen found by us in this mound was sent to the United States Army Medical Museum. Dr. D. S. Lamb, pathologist of that institution, kindly has reported on the bone as follows:

"The right femur, from mound near Douglas, Arkansas County, Ark., Burial No. 12, shows marked atrophy of the head of the bone and downward displacement, the neck forming an acute angle with the shaft, probably a case of tuberculous hipjoint. I say 'probably,' but I know of no other cause than tuberculosis that would cause such a lesion."

But few artifacts except pottery were present in the mound. With several burials were shell beads.

Burial No. 9 had a bottle and a bowl near the skull, and at the neck, tubular beads of sheet-brass and small shell beads.

Burial No. 17, a bunched burial, had at one end two skulls side by side. Immediately above one of these skulls, and covering part of it and the whole of a downturned vessel resembling the one shown in Plate XIX, which lay against the skull, was an inverted bowl, decorated with red paint. Alongside the first-mentioned vessel, but not covered by the bowl, lay, on its side, a small vessel of the "teapot" variety. Near this group of vessels were two others, one being a small bottle, decorated with a coating of red pigment; the other, a little vessel of coarse, yellow ware, having two compartments—no doubt a highly-conventionalized, open-bivalve form. With the two skulls described (which had belonged to adults) and their accompanying bones, were the skull and bones of an infant, which fact explains, no doubt, the presence of the smaller vessels. Near the chin of the infant's skull, that is to say at the neck, was a necklace of tubular beads of sheet-brass, the material on which they were strung still holding the beads in place. Near these were two diminutive, penannular bracelets of sheet-copper, of a size suited to baby arms (Fig. 41), round in cross-section, and tied together, the cord still intact through the agency of the salts of copper. Near the bracelets were one glass bead and one tubular bead of brass.

At the opposite end of this bunched burial, away from the skulls, were two vessels together, both inverted and both (a bottle and a "teapot") belonging to classes of vessels rarely found in that position.

Burial No. 22, that of an infant, had near small fragments of the skull, a necklace (Fig. 42) made up of tubular beads of sheet-brass and shell beads, the material on which the beads were strung being still capable of sustaining the weight of the necklace. Nearby were nine large shell beads, and a few shells kindly identified by Dr. H. A. Pilsbry as *Marginella apicina*. A part of each of these shells had been cut away to fit them for use as beads, and some of them were still in place on a fragment of cord. Doubtless all of them had formed part of the necklace.

Five pebbles, two of which were much polished on one side, lay together under part of an earthenware vessel.

With a burial were two vessels, one of which, a bowl, was inverted over a mass of what Dr. H. F. Keller has determined to be almost pure kaolin. This clay, no doubt, served as white paint, as we have pointed out elsewhere in this report.

Fifty-three vessels came from the mound at Douglas, taking into account all that were found, though many were crushed beyond restoration. The vessels present little variety of form and do not vary greatly in decoration.

Practically every bowl met with was inverted, as were some other vessels, but very exceptionally the bottles.

Some vessels were interesting as to apposition.

Vessel No. 45, a bowl, was inverted over a small bowl and a very diminutive bottle, both of which were lying on their sides.

FIG. 41.—Necklace of beads of sheet-brass and bracelets of sheet-copper. With Burial No. 17. Douglas. (Full size.)

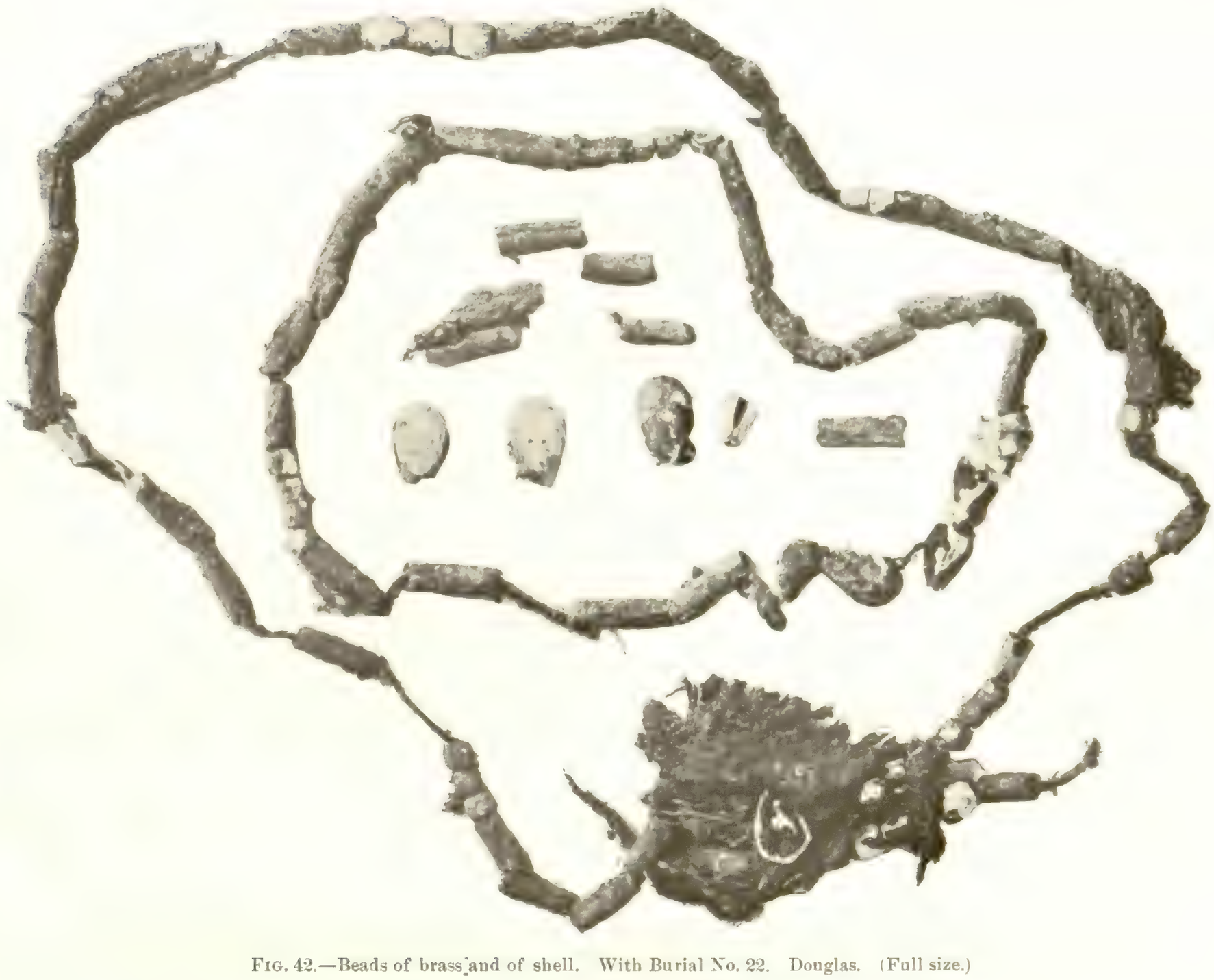


FIG. 42.—Beads of brass and of shell. With Burial No. 22. Douglas. (Full size.)

A small vessel of the "teapot" variety had a small cup turned over the opening of the body.

We give in detail descriptions of more noteworthy vessels found in the mound near Douglas.

Vessel No. 22. This bowl of gray ware (Plate XVIII) has the usual band of red pigment on the upper portion, inside and out. Interiorly is a combination of festooned bands, three bands on each of the four sides, probably sun-symbols.[1]

FIG. 43.—Vessel No. 7. Douglas. (Diameter 7.5 inches.)

Vessel No. 7, a bowl of yellow ware with the usual marginal decoration of red paint on both sides (Fig. 43), has, in the interior, a design somewhat resembling a pair of antlers, perhaps an attribute of the horned serpent.

Vessel No. 17 is a bowl similar to the one just described with the exception that the lower, interior decoration is a cross of the four directions, with equidistant projections downward from the encircling marginal band—perhaps subdivisions of the four directions (Fig. 44).

[1] C. C. Willoughby, *op. cit.*, p. 13.

CERTAIN MOUNDS OF ARKANSAS AND OF MISSISSIPPI.
NEAR DOUGLAS, VESSEL NO. 22. (FULL SIZE.)

COCKAYNE, BOSTON.

FIG. 44.—Vessel No. 17. Douglas. (Diameter 6.4 inches.)

Vessel No. 50 is a bowl of yellow ware having a solid coating of red on the inside. In place of the usual head derived from life is a blunt-pointed handle turning inward, having a perforation. On the opposite side is the usual conventional tail (Fig. 45).

Vessel No. 3 is a small vessel with four equidistant protuberances around the rim, resembling the well-known loop-handles so often found in southern United States. In this case, however, two of these protuberances have been perforated after the baking of the clay, for purpose of suspension, while the other two remain solid. For decoration, this bowl has an interior coating of red paint, and a band of red pigment surrounding the upper, outer part.

Vessel No. 15 is a bowl of excellent, dark, smooth ware, with incised decoration, shown in Fig. 46, in which the meander and the discs, which are probably sun-symbols, have a conspicuous place. Red pigment has been used in the lines of the upper, or flaring, part of the outside of the bowl, while white pigment appears exteriorly in the decoration of the body of the vessel.

FIG. 45.—Vessel No. 50. Douglas. (Diameter 5.6 inches.)

Vessel No. 1, a bottle of light yellow ware, 8.2 inches in height, has a globular body, which, including the neck, has a beautifully polished, even coating of red pigment.

Many bottles of this class, though with the color less excellently preserved, were found by us in the lower Arkansas region, but they will not be described particularly unless offering some point of divergence.

Vessel No. 79 is a bottle only 2.8 inches in height, evenly coated with red paint. This toy, as might be supposed, lay with the skeleton of an infant.

Vessel No. 30. This beautiful vessel (Plate XIX) has an even coating of cream-colored pigment on the outside, and of carmine over the entire interior.

CERTAIN MOUNDS OF ARKANSAS AND OF MISSISSIPPI.
NEAR DOUGLAS. VESSEL NO. 30. (FULL SIZE.)

COCKAYNE, BOSTON.

CERTAIN MOUNDS OF ARKANSAS AND OF MISSISSIPPI.
NEAR DOUGLAS, VESSEL NO. 32. (FULL SIZE.)

We are unable to say with certainty just what this vessel represents; whether it is modeled after a section of a gourd or is a conventionalized shell-form. On each of the four[1] vessels found by us is a protuberance opposite the projecting part, which part, in the case of a shell, would represent the beak; or the neck in the case of a gourd. In conventionalized shell-forms which we have seen, where the conch (*Fulgur*) drinking-cup is represented, there is a group of knobs around a central protuberance.

On the other hand, nearly all gourd-vessels have a depression in place of a knob, and rightly so since the depression represents the actual one seen on that part of the gourd which is opposite the neck. *Per contra*, as we have pointed out in this paper, vessels unmistakably representing gourds sometimes have a knob in place of a depression.

FIG. 46.—Vessel No. 15. Douglas. (Diameter 5.8 inches.)

Vessel No. 51, a diminutive "teapot" of dark ware, was found with part of a small boat-shaped vessel inverted over the opening in the body.

Vessel No. 32, a "teapot," has the spout and knob surrounded by circles of white pigment. On the two other sides of the vessel are round markings in white enclosed in circles of red with small, intervening, circular spaces of the yellow of the ware, as shown in Plate XX.

Vessel No. 21 is also a "teapot" but somewhat larger than the one just described. It is decorated in the same manner, with the addition of some black pigment that has been present on the basal portion, but which is now hardly more than a stain.

[1] There were found by us along the Arkansas river four such vessels, differing only in size, with a single exception. The knob on one of the vessels is surrounded by four small, incised, concentric circles.

Cemetery near Greer, Jefferson County.

Greer, a small settlement, is on the right bank of the Arkansas river, going up, 27 miles by water above the city of Pine Bluff. At Greer is the plantation of Mr. G. B. Greer, five or six thousand acres in extent. After considerable bargaining with this gentleman, carried on through his son, we acquired the right to dig on the plantation.

On the Greer estate is an aboriginal mound that has been used as a cemetery in recent times, and which is covered with tombstones and is carefully fenced in.

In the field surrounding the mound were many signs of aboriginal occupancy, such as bits of pottery; arrowpoints of chert, broken as a rule; pebbles; chips of chert, etc. The canine tooth of a large carnivorous animal, and a small and neatly made "celt," lay upon the surface, as did also a small ornament, probably of sedimentary rock, with a cutting edge at one end and a hole for suspension at the other (Fig. 47).

Fig. 47.—Pendant. Greer. (Full size.)

Investigation was carried on by sinking trial-holes and trenches where signs of occupancy seemed most promising, and then by digging throughout the area where burials were encountered.

Most of our successful digging was done in two small areas, one about 40 yards in a southerly direction from the mound; the other about 30 yards northeast of it, where burials were found in considerable numbers, eighty in all being encountered, twenty of which were of infants and of older children.

These burials, none of which was more than 2 feet from the surface (few attaining that depth), consisted, as a rule, of skeletons at length on the back and of those in a flexed position.

There occurred, in addition, a number of times, three rather unusual forms of interment which, however, are modifications of the same form, namely:

1. Where the trunk lay upon the back, the thighs raised upward and parted somewhat, with the legs bent back on the thighs.

2. The trunk on the back, the thighs widely separated and drawn up, the legs flexed against the thighs.

3. The thighs and legs in the position just described with the trunk bent forward, sometimes to such an extent that the skull touched the pubic part of the pelvis, and sometimes so that the cranium rested to one side of the pelvis.

These forms were encountered ten times in all: once in the site southward from the mound, and nine times in the area northeast of it, though about the same number of burials was present in each site.

But one bunched burial was found at Greer, and this one unmistakably was of the bunched variety, inasmuch as some long-bones belonging to at least three skeletons were neatly piled, parallel—with but one skull, however, which lay beneath the pile.

There were present also disturbances in which bones had been disarranged by

the aborigines when making other burials; and there were, of course, many burials that had been disturbed by the plow.

Fire had been employed but once. A skeleton lay in order down to the upper part of the thorax, unaffected by heat. From this point downward were charcoal and fragments of bones, including parts of the lower long-bones, some of which were burned considerably, but were not calcined.

Most of the bones at Greer were in better condition than we have been accustomed to find them, some skulls being saved. Nearly all the skulls and fragments of skulls showed antemortem compression, though there were exceptions to this rule.

Burial No. 59 at Greer has been referred to in the introductory portion of this report. Many long-bones of this skeleton, which show marks of a specific disease, were sent to the United States Army Medical Museum, while the skull is at the United States National Museum and is included in the report by Doctor Hrdlička. This burial was 2 feet below the surface. The skeleton was partly flexed on the right side, a distinctly aboriginal form of burial. There were no artifacts with it, but it lay among burials which had them.

Not many feet from Burial No. 59 were recent burials in coffins, doubtless the remains of negroes, former laborers on the plantation.

We do not believe, however, that under the circumstances as we have given them, there can be any ground to suppose that Burial No. 59 can have been recent.

But few artifacts, with the exception of pottery, lay with the dead.

A neatly made "celt," rounded at one end, after the southern fashion, lay near a burial. This implement we presented to a visitor.

There were also, associated with human remains: a few shell beads in several instances; several tines of deer-horn, each showing marks of separation from the antler by the aid of a cutting-tool; a piercing implement of bone with the articular part remaining; two implements (found separately) similar in every respect to the last, with the exception that the points are blunt and rounded—seemingly just fitted to make broad lines on clay previous to firing; three fragmentary teeth found together, probably incisors of the beaver; a number of lanceheads and knives, of chert; and a small and beautifully-made double-pointed implement of chalcedony.

With a burial were a number of tubular beads of sheet-copper, with overlapping edges, which had stained bright green a cervical vertebra and the chin. Some of these beads, analyzed by Dr. H. F. Keller, proved to be of the purest copper, as we have related in the early part of this report, a copper far too pure to have been obtained from Europeans, whose supply was derived from impure, sulphide ores.

In the soil, but not associated with burials, were the usual hammer-stones, broken and whole; also chisels and cutting implements, some wrought from chert pebbles; a small disc, probably of fine-grained sandstone; and a piercing implement of bone, with a perforation at the blunt end.

Throughout the investigation at Greer 160 vessels of earthenware were found, or an average of exactly two to each burial.[1]

Only a few burials were without a mortuary deposit of vessels, ranging from one to five in number. These vessels were found, not in a great majority of instances near the skull, as was the case in sites farther down the Arkansas river, but arranged variously. Sometimes vessels lay near the skull, in one instance the head being entirely surrounded with them, or again vessels were found along the arm, near the thighs, at the knees, or at the feet. For example, Burial No. 7, a skeleton lying partly flexed on the left side, had at the right shoulder a water-bottle, another vessel at the elbow, and a bowl at the feet.

Burial No. 61, a skeleton having the lower extremities extended and the head and trunk flexed over and turned to the right, had, under the skull, a bowl containing a smaller bowl; at the elbow, a bottle; over the left knee, a bowl; at the right thigh, a large bowl with a smaller bowl somewhat above it.

But few vessels at Greer had been placed in the ground, inverted.

In certain respects the earthenware found at Greer differs from that met with by us farther down the river. The use of red paint as a coating for vessels was exceptional in this cemetery, while decoration made up of red designs and white designs in combination was found but twice, though red pigment appears in a number of instances worked into the lines of incised decoration.

But one vessel of the "teapot" variety was met with at Greer, and this vessel was found with a burial at a distance from the two sites whence all the rest of the pottery was taken.

The ware from Greer is largely dark, not highly polished, and, when decorated, bears in almost every instance a scroll decoration made up of broad, trailed lines, and offering little variety of combination. The majority of the ware is undecorated and of inferior quality, especially that placed with the bodies of children, a rather exceptional circumstance, for the aborigines, as a rule, were liberal when interring their little ones. As usual, vessels with children's remains were small in keeping with the size of the departed.

In many of the vessels were large musselshells, too fragmentary for identification, as a rule, though in one case Dr. H. A. Pilsbry has identified one to be *Lampsilis purpuratus*.

Red pigment was found in several vessels We have already quoted (page 484) the analysis by Dr. H. F. Keller of red ocher from this place.

Part of a rude smoking-pipe of earthenware was found in the soil, apart from human remains.

We shall now describe the vessels from Greer, which merit particular notice.

[1] In this enumeration all vessels have been scored, whether whole, partly broken or hopelessly crushed by the plow (the last two classes greatly predominating), our object being to ascertain as nearly as possible the number originally placed with the dead, though, of course, owing to the destruction of the human remains and of vessels through cultivation of the field, it was impossible to do this with exactness.

Vessel No. 100 is a shallow bowl of dark ware (Fig. 48), having as decoration, incised over the entire base, an interesting form of the swastika—a variety found in the United States and in Central America.[1]

Professor Holmes has kindly prepared for us the following note[2] on this form of swastika:

FIG. 48.—Vessel No. 100. Greer. (Diameter 6.4 inches.)

"With regard to the device engraved on the bottom of the earthen bowl, you will remember that it occurs on engraved shells and in various degrees of convention on the stamped earthenware of the Southern States. It is also a very general

[1] Thomas Wilson, "The Swastika," Rep. U. S. Nat. Mus., 1894, p. 902.

[2] See, also, William H. Holmes, "On the Origin of the Cross Symbol," Proc. Am. Antiq. Soc., Oct. 24, 1906.

occurrence on the pottery of the ancient Pueblos—especially the cliff dwellers. The design is merely a form of the cross popularly known as the swastika. The cross in all of its forms is a cosmic symbol representing the world (the primitive universe), the division into four (north, south, east, west) being the convenient means of locating the groups of deities to which offerings and appeals had to be made. We may thus regard it as the symbol not so much of the universe itself, as of all the vast number of deities, powers, and agencies of good and evil supposed by aboriginal peoples to occupy the four quarters of their world."

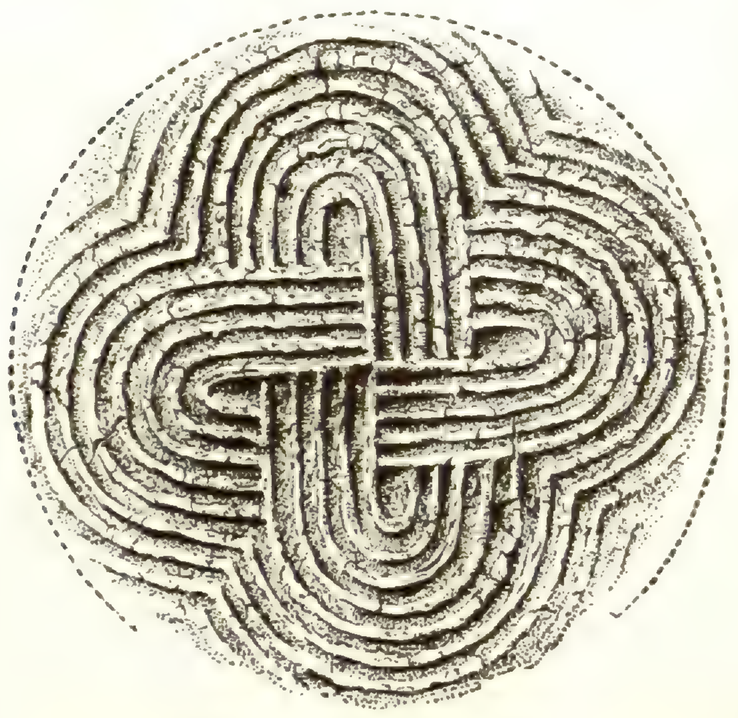


FIG. 49.—Swastika, a stamped decoration on South Apalachian ware. (Holmes.)

In Figs. 49, 50, 51, 52, are shown illustrations suggested by Professor Holmes in connection with his remarks.

Vessel No. 56. This beautiful bottle of dark ware, having an oblate-spheroidal body and flat base (Fig. 53), bears an incised decoration on two sides, showing a swastika of a variety akin to the one seen on Vessel No. 100. Between the two crosses is a minor decoration, probably added to fill space. Still remaining in the incised lines are traces of red pigment.

FIG. 50.—Shell gorget with swastika decoration. (Half size.) (Holmes.)

Vessel No. 111. This bottle, of hard, yellow ware, with a flat, annular base (Fig. 54), has, in trailed, broad lines, a swastika decoration of the same class as the two already described.

Vessel No. 64, which in reality is but the basal part of a vessel, evidently bore, when entire, an incised decoration in which a swastika similar to those just mentioned, formed a part. As much as was found of this vessel is shown in diagram in Fig. 55.

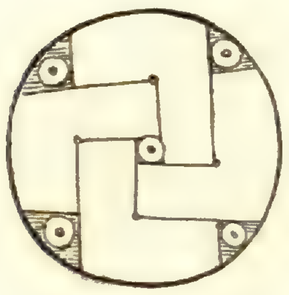


FIG. 51.—Swastika. (Holmes.)

FIG. 52.—Swastika. (Holmes.)

Vessel No. 48. This vessel, of dark ware, polished (Fig. 56), in shape, we believe, differs from any hitherto described as coming from the middle Mississippi region. In form it resembles a saucer with a perforated, trun-

FIG. 53. -Vessel No. 56. Greer. (Height 8.6 inches.)

cated cone as a support, and recalls to some extent the basal part of certain bottles from the region in question. This vessel is without decoration.

Vessel No. 51 belongs to the same class as that just described, but differs from it in that the support has a greater number of perforations and the vessel bears incised decoration. Around the lower part of the support is an encircling, incised line, in connection with which are oblique, parallel, incised lines (Fig. 57).

FIG. 54.—Vessel No. 111. Greer. (Height 4.8 inches.)

The interior of the upper part bears an interesting, incised decoration (Fig. 58), in relation to which, and to the decoration on the two vessels described after this one, we have consulted with Mr. Charles C. Willoughby,[1] for whose assistance in this matter we wish to express our thanks.

The central figure, of course, is the cross of the four directions, while the cross-

[1] The reader is referred also to Mr. Willoughby's paper, "An Analysis of the Decorations upon Pottery from the Mississippi Valley," Journal of American Folk-Lore, Vol. X, 1897.

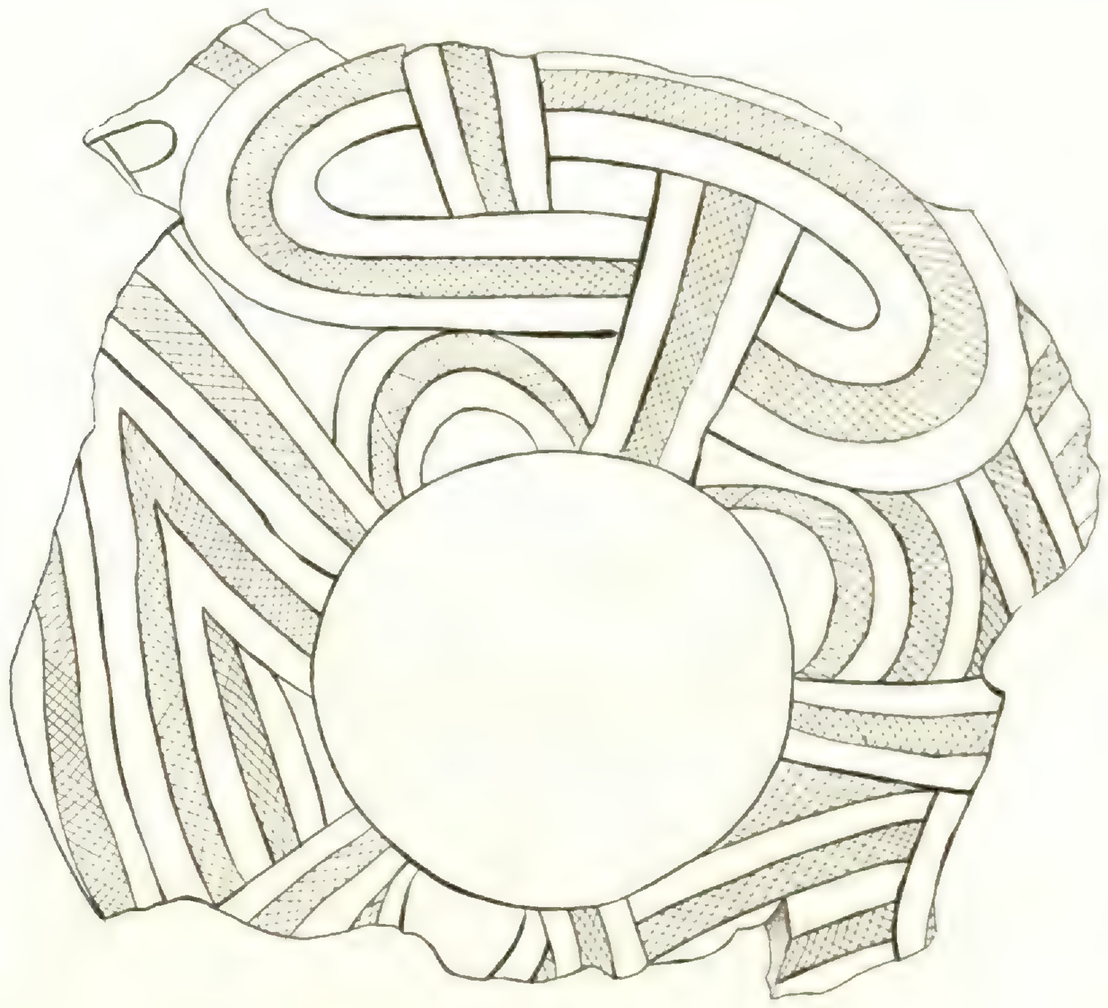


FIG. 55.—Vessel No. 64. Greer. Decoration. (Half size.)

FIG. 56.—Vessel No. 48. Greer. (Diameter 6 inches.)

hatch figure is a swastika. Mr. Willoughby thinks the four circles near the edge in this decoration are analogous to the four circles common to similar designs in which each of the circles surrounds a cross that has within each of the four spaces formed by its arms, a small circle surrounding a dot.

Mr. Willoughby does not believe that the cross-hatch near the edge and around the circles in the design figured by us forms a special design, but rather is used as a back-ground.

Vessel No. 79. We have here part of another vessel (Fig. 59) of the same type as the two just described. Red pigment remains in the lines of the incised decoration. This decoration, partly restored, is shown in diagram in Fig. 60.

FIG. 57.—Vessel No. 51. Greer. (Diameter 6.3 inches.)

Mr. Willoughby thinks, but does not feel sure, that the central design is made up of serpents' tails with rattles. If such be the case, the rattles are represented by the cross-hatch design. The remainder of the decoration on this vessel much resembles that on Vessel No. 51, with the introduction, however, of four additional circles.

Vessel No. 17. This saucer-like vessel of dark, smooth ware (Fig. 61), has a most interesting, engraved decoration covering its entire outer surface, which probably represents various parts of the serpent. The central design is formed of four tails, showing the rattles. The four lobes surrounding the inner circle and forming a cross, are serpents' mouths, showing their teeth. The smaller circles probably represent the eyes.

In some of the outer semicircles the serpents' teeth appear again, and we believe it likely that the dentate, cross-hatch figures represent crests of the crested serpent, as similar designs are seen on representations of winged and crested serpents, and appear again and again through every form of convention down to the simple scroll.[1]

Mr. Willoughby says: "The complete design seems to me to be analogous to

FIG. 58.—Vessel No. 51. Decoration.

that of a certain type [2] of shell gorgets, which I always believed represented a serpent.

"It is possible that the small circles in all these designs are eyes. It is inter-

[1] C. B. Moore, "Moundville Revisited," Journ. Acad. Nat. Sci., Phila., Vol. XIII, Figs. 65 to 73, inclusive.

[2] W. H. Holmes, "Art in Shell," Second Ann. Rep. Bur. Am. Ethnol., Pls. LIV, LV, LVI.

FIG. 59.—Vessel No. 79. Greer. (Diameter 6 inches.)

FIG. 60.—Vessel No. 79. Decoration. (Two-thirds size.)

esting to note that in the painted designs of the Northwest Coast Indians, eyes nearly always appear at the principal joints of the body. They also appear at the joints of certain gods of the Mexican Indians,[1] and I think that the circles shown at some of the joints in the serpent god of the Cincinnati tablet [2] also represent eyes."

Mr. Willoughby thinks it probable that the complete designs on the three vessels just described represent serpents or serpents combined with cosmic elements.

FIG. 61.—Vessel No. 17. Greer. (Diameter 5.3 inches.)

"The supreme power of the heavens exemplified by the lightning," says Mr. Willoughby, "symbolized by the serpent, is so closely associated with the clouds, wind, rain, water, the four directions, as well as the horizon, that where the representation of one occurs, others are likely to be found. I think that the swastika on Vessels Nos. 51 and 79, while it may refer to the serpent, also denotes the winds."

[1] See Zelia Nuttall, "The Book of Life of the Ancient Mexicans," pp. 76, 79, etc.

[2] The reader is referred to F. W. Putnam and C. C. Willoughby, "Symbolism in Ancient American Art," Proc. A. A. A. S., Vol. XLIV, 1896.

Vessel No. 13. In Fig. 62 is shown a bowl of dark ware, with a scroll design formed by a combination of broad, trailed lines, a design resembling very many found near Greer. A feature of this vessel, however, is that on two opposite sides of the opening are projections, each containing a longitudinal perforation for suspension.

Vessel No. 34 is a wide-mouthed bottle of dark ware (Fig. 63), the body an oblate sphere, the neck slightly flaring and surrounded at the junction with the body by a band in relief, ornamented with incised chevrons. The decoration is largely a scroll design somewhat similar to many found near Greer.

FIG. 62.—Vessel No. 13. Greer. (Diameter 6 inches.)

Vessel No. 135 is a wide-mouthed bottle (Fig. 64) of the same class as the one just described.

Vessel No. 150 is a broad-mouthed bottle of dark ware, with chevron decoration around the neck and a scroll decoration of broad, trailed lines on the body. A noteworthy feature about the bottle is that on two opposite sides are holes for suspension.

Vessel No. 119 is a bottle of dark ware (Fig. 65), with neck, first upright, then flaring. The decoration is similar in the main to that on other vessels from this place.

FIG. 63.—Vessel No. 34. Greer. (Diameter 6.5 inches.)

FIG. 64.—Vessel No. 135. Greer. (Height 7 inches.)

FIG. 65.—Vessel No. 119. Greer. (Diameter 5.5 inches.)

Vessel No. 10 is a well-made bottle with the usual scroll and attendant decoration (Fig. 66).

Vessel No. 61 has been a large effigy of a quadruped, supported on four legs and painted a brilliant red. Unfortunately, the head and back (and probably

FIG. 66.—Vessel No. 10. Greer. (Height 7.5 inches.)

a neck, as the effigy was most likely a bottle) have been carried away by the sweep of a plowshare. Vessels of a type presumably similar to this one are figured by Holmes[1] and by Thruston.[2]

[1] Twentieth Ann. Rep. Bur. Am. Ethnol., Pl. XXVf.
[2] "Antiquities of Tennessee." Fig. 46; also Pl. IX.

Vessel No. 45 is a bowl of dark ware (Fig. 67), in shape an inverted, trun-

FIG. 67.—Vessel No. 45. Greer. (Diameter 7 inches.)

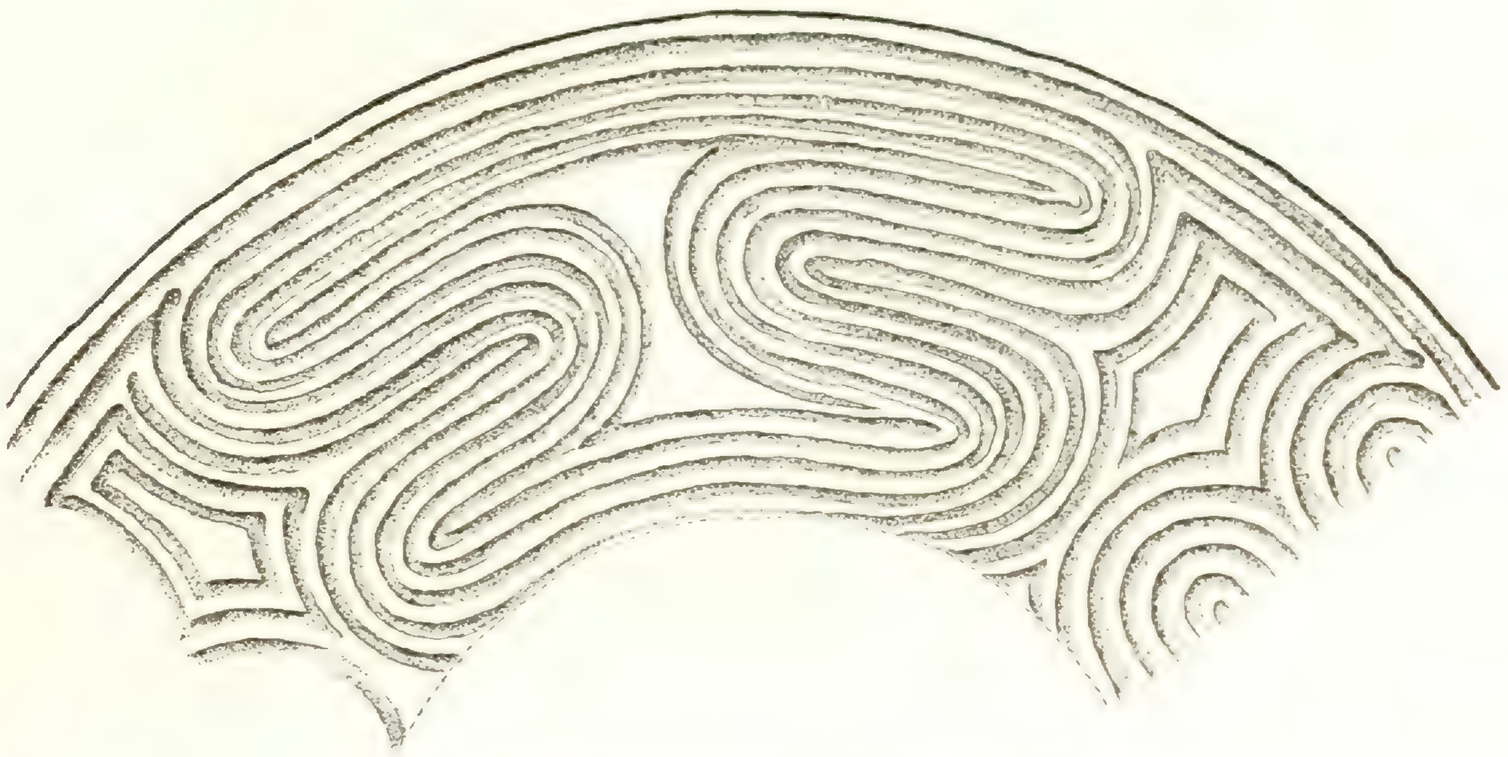


FIG. 68.—Vessel No. 45. Decoration. (Half size.)

cated cone, with a graceful decoration of broad, trailed lines (Fig. 68), shown twice on the outer surface. On the base is a swastika that had become so indistinct

through wear that it was necessary to outline it with chalk for purposes of photography.

Vessel No. 120 is a bowl of excellent, dark ware (Fig. 69), having on the upper part an incised decoration in which remain traces of red pigment.

FIG. 69.—Vessel No. 120. Greer. (Diameter 7.2 inches.)

FIG. 70.—Vessel No. 106. Greer. (Diameter 9.3 inches.)

Vessel No. 106 is also a bowl of dark ware, with an incised decoration that at one time has had a deposit of red pigment in the lines (Fig. 70).

Vessel No. 121 is a wide-mouthed bottle of dark ware, having a body globular with extended flat base, and a neck first upright, then flaring (Fig. 71). The decoration, which is incised, is made up of bands of reticulated lines, most of which unite in forming a scroll effect. As was almost invariably the case in the cemetery near

Greer, red paint is an adjunct to the incised decoration, which, incidentally we may say here, was not employed when the decoration consisted of broad, trailed lines.

Vessel No. 112 is a wide-mouthed bottle of dark ware, with a body having an extension ending in a flat base (Fig. 72). The decoration, incised, with the usual traces of red pigment, is made up of a combination of spaces filled with reticulated lines.

Vessel No. 30 is a bowl of coarse, yellow ware, having an almost indistinguishable decoration on the lower part. The upper part, exteriorly, bears an incised and punctate design in which the scroll has a prominent place (Fig. 73).

FIG. 71.—Vessel No. 121. Greer. (Diameter 6.75 inches.)

Vessel No. 8 is a cooking vessel of yellow ware, with soot still adhering (Fig. 74). The decoration of trailed lines and punctate markings shows scrolls, concentric circles (probably sun-symbols), and diagonal, parallel lines.

Vessel No. 37. This interesting little vessel (Fig. 75) is a reproduction in earthenware of one of the musselshells (*Unio*) found in the Arkansas and White rivers. We do not recall having seen before the musselshell represented in earthenware, though the conch and the clam figure in the pottery of the middle Mississippi region.

FIG. 72.—Vessel No. 112. Greer. (Diameter 7.7 inches.)

FIG. 73.—Vessel No. 30. Greer. (Diameter 5.6 inches.)

Vessel No. 110 is a bowl of yellow ware (Fig. 76), having as decoration a

FIG. 74.—Vessel No. 8. Greer. (Diameter 6.5 inches.)

band of red pigment on both sides, extending somewhat below the rim. In the interior are four series of double, crescentic bands executed in red paint. Centrally, is a frog shown in red paint, the representation of which, however, is somewhat marred through the effect of heat, the outside of the vessel and the central part of the interior having been discolored by fire.

It is interesting to note that a vessel found by Doctor Hough[1] in northeastern Arizona, bears a frog painted on the base of the interior. "The frog is a symbol of water," says Doctor Hough, "and its symbolic use is widely diffused in the Pueblo region, carved in shell, formed in clay, worked in turquoise mosaic or painted on pottery."

The frog shown by Doctor Hough is tailless, while the frog on the vessel from Greer bears a well-developed tail.

FIG. 75.—Vessel No. 37. Imitation of musselshell. Greer. (Full size.

[1] Walter Hough, "Archæological Field Work in Northeastern Arizona," Smithsonian Report, 1901, p. 315, Pl. L.

It is well known that in the tadpole state the incipient frog has, at the same time, both tail and legs, which fact, no doubt, caused the aboriginal artist to portray on our bowl a frog with marked caudal development.

Here again, however, we can find a parallel in the Southwest. Doctor Fewkes[1] describes and figures as coming from the ancient Pueblo of Sikyatki, in

FIG. 76.—Vessel No. 110. Greer. (Diameter 13.5 inches.)

northeastern Arizona, a painted representation of a frog bearing a tail of considerable size.

Vessel No. 32, a bowl of yellow ware (Fig. 77), has an interior coating of red pigment and an exterior band of the same material extending somewhat below the

[1] J. W. Fewkes, "Archæological Expedition to Arizona in 1895," Seventeenth Ann. Rep. Bur. Am. Ethnol., Part II, p. 677, Pl. CXXXIIf.

rim. On opposite sides are an effigy of the human head and a conventional tail.

Vessel No. 55, also a bowl of yellow ware, much the worse for ravages of time, has had an interior coating of red pigment that has almost entirely disappeared. On the outside are traces of the usual band of red paint below the margin. On one side is the head of an unidentified animal with conspicuous ears erect, protruding eyes, and partly open mouth showing the teeth (Fig. 78). On the opposite side a tail curves first upward, then inward.

FIG. 77.—Vessel No. 32. Greer. (Diameter 7.3 inches.)

Vessel No. 9 is a bottle of yellow ware, found in many fragments through contact with a plow, the neck being entirely gone. This bottle has been cemented together with considerable restoration as to the body and complete restoration of the neck (Fig. 79). The design varies somewhat from that on any other vessel found by us along the Arkansas river, though it is of the same general character. Partly interlocked scrolls of white and of red form the decoration, the scrolls having fenestrated ends filled with color—the white scrolls with red, the red scrolls with white. As the paint formerly on this bottle has been considerably worn away, we have attempted in the figure to show the design as it originally appeared, the dark shade representing red; a lighter shade showing the yellow of the ware; the white, of course, being represented without color.

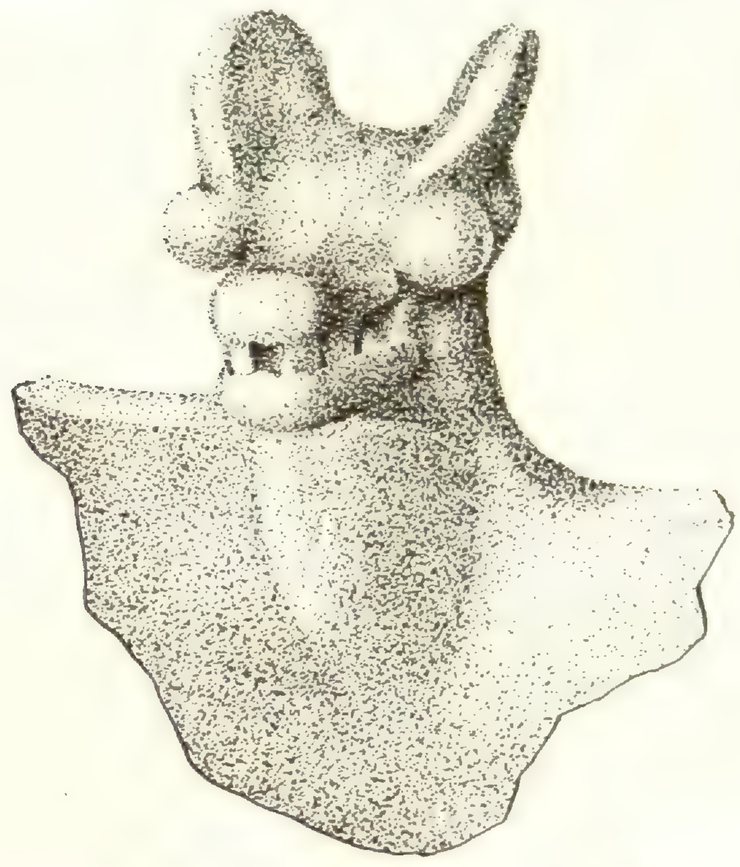


FIG. 78.—Vessel No. 55. Greer. (Full size.)

Vessel No. 136. This small vessel, with rounded base and square in upper, horizontal section, is undecorated and is worthy of note only on account of its quadrangular form which, as has often been remarked, is unusual though of widespread occurrence.

FIG. 79.—Vessel No. 9. Greer. (Height 9 inches.)

The Toltec Mounds, Lonoke County.

These mounds, near Toltec station, on the railroad, about sixteen miles below the city of Little Rock, are described as the Knapp Mounds in the Twelfth Annual Report of the Bureau of American Ethnology,[1] as doubtless they were called at the time of the publication of the Report.

The mounds were visited by us, but investigation was not deemed advisable, as there seemed to be no history of the discovery of artifacts in the vicinity.

Little Rock.

In the State-house at Little Rock, the capital of Arkansas, we examined a small case of earthenware vessels said to have been found in the neighborhood of the city.

One of these vessels, of the "teapot" variety, bears a human face on one side, well modeled in relief, and is one of the most interesting vessels from Arkansas that we have seen.

Since our return, we have tried without success, to obtain from the officials at the State-house a photograph of this vessel for reproduction.

[1] Page 243 *et seq.*

REPORT ON A COLLECTION OF CRANIA FROM ARKANSAS.

(Made, and donated to the National Museum, by Mr. Clarence B. Moore.)

By Aleš Hrdlička.

(In charge of the Division of Physical Anthropology, U. S. National Museum.)

The collection in question consists of twelve more or less perfect skulls, four of which are marked as coming from "near Menard mound, Arkansas Co., Ark.," while six were exhumed "near Greer, Jefferson Co.," the same State.

All the specimens present about the same degree of conservation. They are all of much the same yellowish color, fragile, largely devoid of animal matter, but not mineralized. Two of the skulls are represented by the frontal bone only, and of the others three lack the lower jaw. Their original and Museum numbers, with identification as to sex and estimate of the age of the individuals, are as follows:

Orig. No.	Museum No.	Sex.	Approximate age of person.
Menard Skulls.			
———	249,914	male	55–60 y.
"Burial 10"	249,915	male	50–60 y.
" 86	249,916	female	30–35 y.
———	249,917	female	adolescent.
Greer Skulls.			
"Burial 6"	249,918	female	35 y.
" 60	249,919	male	55–60 y.
" 7	249,920	female	40 y.
" 43	249,921	male (?)	35 y.
" 12	249,922	female (?)	45 y.
" 59	249,923	female	35 y.
" 32	249,924	female	40 y.
" 53	249,925	female	35 y.

Several of the skulls show signs of injury in life, or of disease. Thus, in 249,915 (Menard), a hyperostosis of the plate that forms its floor occludes entirely the right external auditory meatus, while on the left side there is a similar condition in an advanced stage; in 249,919 (Greer), there are three scars of old lesions of unknown nature, one, of moderate size and irregular form, anteriorly near the right frontal eminence, a trace of a similar one in nearly the same location on the opposite side, and a large scar over the upper third of the right parieto-occipital articulation; in No. 249,920 (Greer), there is a larger (3 x 2 cm.) scar, resembling in nature those in the preceding case, on the left frontal eminence; in No. 249,921 (Greer), a large symmetrical area over the top and back of each parietal shows

signs of prolonged congestion, resulting in slight hyperplasia of the surface bone layer; finally, No. 249,922 shows an old scar in the large inion depression which exists in this case, and in one part of this scar the bone is perforated, the irregular opening measuring 6 x 5 millimeters. All these scars suggest syphilitic lesions, but they are all healed and there is a total absence of the characteristic syphilitic ulceration of the bone. Besides the just mentioned conditions, it is noticeable that dental caries was more prevalent than is usual among the Indians.

Three of the Menard and three of the Greer crania show various degrees of artificial, intentional deformation of the "flathead" type, and one additional Greer skull (249,922) presents a lateral occipital flattening. Specimens 249,917, '20, '21 and '23 are free from deformation; in 249,915 and '925 the frontal compression is of so light a grade that it does not affect materially the general shape and measurement of the skulls.

Anomalies of structure are observable in a number of cases, those more worthy of mention being as follows: An epactal bone, 4.3 x 9.9 cm. in surface measurements, exists in 249,920; and there is, in 249,918, a somewhat rudimentary atlas, with complete neural arch, fused entirely with the occipital.

The anthropological characteristics of the skulls from the two localities are found on examination to be practically identical. They are so close that there is a strong probability of their proceeding not only from the same general type, but even from the same tribe of people, and they can be legitimately dealt with as one group only.

Measurements and Description.

Form.—The undeformed skulls of this collection are all decidedly brachycephalic, and several of the deformed specimens give plain indication that they belong to the same type. The skulls are also all relatively high. The individual measurements and indices showing these conditions are as follows:

Measurements of the Crania Relative to their Shapes.

Museum Number	Sex	Diameter antero-posterior maximum	Diameter lateral maximum	Basion—bregma height	Cephalic index	Height—length index	Height—breadth index
		cm.	cm.	cm.			
249,915	Male	17.8	15.4	14.3	*86.5*	*80.3*	*92.9*
249,919	Male	16.5	14.8	14.6	*89.7*	*88.5*	*98.6*
249,920	Female	16.2	14.5	13.9	*89.5*	*85.8*	*95.9*
249,921	Male (?)	17.2	14.5	14.15	*84.3*	*82.3*	*97.6*
249,923	Female	16.5	14.3	13.7	*86.7*	*83.0*	*95.8*
249,925	Female	15.7	13.9	13.6	*88.5*	*86.6*	*97.8*

Size.—The skulls under examination are all of rather low capacity, when compared with whites, but can not be said to be exceptional for Indians, particularly for those of moderate stature, which in this case is indicated by the usual small lumen of the foramen magnum, as well as by a few of the long-bones sent by Mr. Clarence B. Moore to the Army Medical Museum (a right male femur among these measures 41.1 cm.). The next table gives a number of determinations which have relation to the size of the skulls; it will be seen that it is of importance to learn, in connection with the external measurements, also the approximate thickness of the bones that form the cranial vault, to be enabled to judge with some accuracy as to the capacity. The thickness of nearly all of these skulls is above the average in whites, though agreeing with that usual in the Indian.

MEASUREMENTS OF THE CRANIA RELATIVE TO THEIR SIZE.

MUSEUM NUMBER	Sex	Capacity in c.c. (writer's method)	Cranial module (=mean diameter)	Circumference (above supraorbital ridges)	Nasion—opisthion arc	Thickness of left parietal (above the squamous suture)
		c.c.	cm.	cm.	cm.	mm.
249,915	Male	1425	15.83	51.8	34.5	6–7
249,919	"	1345	15.30	49.9	33.8	4–6
249,921	" (?)	1260	15.28	50.7	35.2	6–7
249,922	Female (?)	1305	15.07	48.0	33.8	4–6
249,916	Female	1290	14.80	48.2	32.5	4–6
249,918	"	1170	NEAR 14.90	47.0	NEAR 33.3	6–7
249,920	"	1185	14.87	48.6	33.8	4–6
249,923	"	1250	14.83	49.1	33.9	4–6
249,924	"	1240	14.90	48.8	32.6	4–6
249,925	"	1140	14.40	46.3	32.3	3–4

The *facial parts* of these skulls gave measurements which are grouped in the next tables. It is seen that the upper facial height is in most of the instances quite considerable. This is due to a relatively great development in height of the upper alveolar process, which assumes really exceptional proportions in No. 249,916. The total facial height is less pronounced, due to a relative lowness of the inferior maxilla. The breadth of the face is throughout moderate. The nasal index is

grouped about the boundaries of the lepto- and mesorhynic, the orbital index is variable, with a predominance in the undeformed skulls of the mesoseme. The prognathism is on the average only slightly greater than is usual among the Indians, but is excessive in two of the specimens (Nos. 249,916 and 249,924). The palate is predominantly brachyuranic (Turner). The angle of the lower jaw presents nothing unusual, with one possible exception (No. 249,921, abnormally large, if this skull is that of a male). The breadth as well as the height at symphysis of the lower jaw are both moderate in all the specimens.

Measurements Relative to the Facial Parts.

Museum Number	Sex	Total height of the face	Alveolar point—nasion height	Diameter bizygomatic maximum	Facial index, total	Facial index, upper	Nose: Height (mean of that from nasion to the nasal notches)	Nose: breadth	Nose: index	Orbits: mean height	Orbits: mean breadth (Broca)	Orbits mean index
		cm.	cm.	cm.			cm.	cm.		cm.	cm.	
249,915	male	12.4	7.7	14.6	*84.9*	*52.7*	5.45	2.75	*49.1*	3.40	4.50	*75.6*
249,919	"	?	?	14.5	*?*	*?*	5.00	2.50	*50.0*	3.20	3.85	*83.1*
249,921	" (?)	11.9	7.45	13.2	*90.1*	*56.4*	5.40	2.50	*46.3*	3.45	3.90	*88.5*
249,922	female (?)	12.0	7.35	13.2	*90.9*	*55.7*	5.05	2.30	*45.5*	3.50	4.05	*86.4*
249,916	female	13.2	8.05	12.7	*103.9*	*63.4*	5.20	2.45	*47.1*	3.65	3.70	*(98.6)*
249,918	"	11.6	7.1	13.7	*84.7*	*51.8*	4.90	2.50	*51.0*	3.30	3.75	*(88.0)*
249,920	"	?	?	?	*?*	*?*	?	?	*?*	?	?	
249,923	"	10.0	6.7	13.3	*81.9*	*50.4*	5.15	2.55	*49.5*	3.50	3.75	*93.3*
249,924	"	12.0	7.65	13.1	*91.6*	*58.4*	5.30	2.40	*45.3*	3.50	3.75	*(93.3)*
249,925	"	?	7.25	12.8	*?*	*56.6*	5.20	2.60	*50.0*	3.40	3.60	*94.4*

Additional Measurements Relative to the Facial and Other Parts of the Skull.

Museum Number	Sex	Prognathism						Palate			Lower Jaw			Frontal Bone		Foramen magnum: mean diameter
		Basion—forepart of alveolar point (*a*)	Basion—nasion (*b*)	Angle between *a* and *b*	Basion—middle of nasal notches (*c*)	Height from alveolar point to middle of nasal notches (*d*)	Angle between *a* and *d*	External length (x)	External breadth (y)	Index $\left(\frac{y \times 100}{x}\right)$	Diameter bigonial	Angle (mean)	Height at symphysis	Diameter frontal minimum	Diameter frontal maximum	
		cm.	cm.	degrees	cm.	cm.	degrees	cm.	cm.		cm.	degrees	cm.	cm.	cm.	cm.
249,914	male	?	?	*?*	?	?	*?*	?	?	*?*	?	*?*	?	ABOUT 10.0	(12.3)	?
249,915	"	10.7	11.4	*74.0*	9.8	2.10	*57.5*	5.8	NEAR 6.9	*119.0*	10.9	*116.5*	3.4	9.8	(12.3)	3.35
249,919	"	?	10.5	*?*	8.95	(1.95)	*?*	?	?	*?*	?	*?*	?	10.15	12.6	3.15
249,921	" (?)	10.2	10.5	*73.0*	9.0	2.20	*52.5*	5.8	6.9	*119.0*	11.0	*134.0*	NEAR 3.6	9.4	12.4	3.50
249,922	female (?)	10.2	10.6	*73.0*	9.15	2.45	*58.5*	5.75	6.6	*114.8*	9.6	*126.0*	3.5	9.4	11.6	3.00
249,916	female	10.4	10.0	*63.0*	9.0	2.85	*52.0*	6.2	7.1	*114.5*	9.9	*?*	?	9.85	(13.2)	3.05
249,917	"	?	?	*?*	?	?	*?*	?	?	*?*	?	*?*	?	9.2	11.8	?
249,918	"	?	?	*?*	?	2.30	*?*	5.6	6.9	*123.2*	10.0	*121.0*	3.25	8.8	(11.5)	?
249,920	"	?	9.8	*?*	?	?	*?*	?	?	*?*	?	*?*	?	8.9	11.95	2.90
249,923	"	9.4	9.9	*73.5*	8.5	1.75	*55.0*	5.35	6.8	*127.1*	10.1	*125.0*	3.15	9.4	12.4	3.30
249,924	"	10.6	10.2	*66.5*	9.3	2.35	*51.5*	5.8	6.65	*114.7*	9.8	*129.0*	3.5	9.2	(12.5)	3.25
249,925	"	10.0	10.15	*70.0*	9.0	2.10	*56.0*	5.6	6.55	*117.0*	?	*?*	?	9.1	11.5	3.25

Descriptive Notes.—In the undeformed skulls, the forehead is generally well built; the sagittal region is anteriorly uniformly oval, or there is but a slight median elevation, while from the summit backward and particularly in the region of the obelion, a number of the specimens show a shallow median depression; the temporo-parietal region is convex, without bulging, and the parietal bosses are not pronounced; the occiput is also convex, without bulging, as it does in long crania. In several instances the locality of the inion, usually marked by a protuberance, presents a depression; this is especially marked in Nos. 249,918 and 249,922.

The supraorbital ridges are in all these crania less developed than usual, while the opposite is true of the mastoids, particularly those of the females, which are much above the average and could in most of the cases easily be taken for those of males.

The sutures show generally a submedium serration; obliteration is irregular in the different specimens, but in a number of instances is seen to have involved the coronal suture below the temporal ridges before it has advanced much in other localities. The pterions are all of the H form and mostly of fair width. Sutural bones are small and quite infrequent.

The nasion depression, due to the small supraorbital ridges, is generally more or less shallow; the nasal bridge is of but moderate height, especially in 249,925; the inferior borders of the nasal aperture are in most of the cases sharp, but in 249,918 they are dull, with moderate subnasal gutters, while in 249,923 they are dull and there are moderate subnasal fossæ. The spine, as usual in the Indians, is mostly of submedium dimensions as compared with that of whites.[a]

The malar bones and zygomæ are in all these specimens of only moderate strength and prominence. The canine, or submalar fossæ, are of medium development. The chin is generally of moderate protrusion; in 249,921, and especially in 249,915, it is square. The angles of the lower jaw are in no case prominent.

The base is characterized by small depression of the petrous bones, small middle lacerated foramina, and submedium to rudimentary styloids—all features common in Indians. In two of the ten skulls, in which the examination of the floor of the auditory meatus is possible, there is a small defect in the same—in 249,921 on the left, in 249,922 bilaterally.

The dentition has been found regular and complete in all cases where it was possible to examine the same, except in 249,919, where there are traces of one or possibly two rudimentary, supernumerary dental elements in the upper jaw on the right side. The teeth are in all cases of moderate size. The upper incisors, where preserved, show the pronounced ventral concavity, or shovel form, which is encountered in nearly all of the Indians. The cuspidary formulæ, so far as they could be ascertained, differed in no way from what is most usually found in the whites. The wear of the teeth is less than usual in other localities.

[a] This structure is subject to so much variation, and is so often damaged, particularly in old skulls, that the writer finds it impracticable to utilize it as the point from which the nasal height is to be measured, utilizing instead the mean of the lowest points on the border of the two notches of the nasal aperture.

Deductions.—The collection of skulls described above, consists of one well defined type, characterized mainly by brachycephaly. There are, in addition, features which may be regarded as local or tribal modifications, connected probably in the main with the habits and environment of the people, consisting in more than usual development in height of the upper alveolar process, a considerable development of the mastoids in the females, and small development, in both sexes, of the supraorbital arches. The people were not tall in stature, and their food was not coarse.

The type of people indicated by the skulls prevailed at one time over a large part of the present State of Arkansas, and extended to the Gulf States. Its exact limits are as yet but ill defined. It stands in relation—regardless of the custom of head deformation—with a large contingent of the mound Indians, reaching well into Ohio. More distant peoples of fundamentally the same type are, on one hand, the brachycephals of the northwest coast, and, on the other, the people of Yucatan and parts of the eastern coast of Mexico. The southwestern brachycephals must also be borne in mind.

There are doubtless, in the Gulf States, yet living representatives of the type of people indicated by the Arkansas skulls here described. It exists to an unascertained extent among the Tonkawa. And the type is predominant, if not general, among the Choctaw. To learn its ancient distribution would be an important step in the anthropology of this country.

MAP OF PARTS OF THE YAZOO AND SUNFLOWER RIVERS

Scale in miles

0 5 10 15

1908

CERTAIN MOUNDS OF ARKANSAS AND OF MISSISSIPPI.

By Clarence B. Moore.

PART II.

Mounds of the Lower Yazoo and Lower Sunflower Rivers, Mississippi.

The Yazoo river has its origin in the northwestern part of the State of Mississippi, and flows in a southerly course through the eastern part of the alluvial plain of the Mississippi valley, to its union with the Mississippi river, near the city of Vicksburg.

The Sunflower river has its source somewhat to the westward of that of the Yazoo, and continues southward to its junction with the latter stream, about 44 miles by water above Vicksburg.

The Yazoo region is of considerable archæological interest, since the Yazoo Indians, who dwelt not far from the mouth of the river that bears their name, were at no great distance north of the famous Natchez Indians who, as the reader is aware, were found by the early explorers living near where now is the city of Natchez, Miss. The Yazoo had been, no doubt, long under the influence of the Natchez Indians, and in 1730 we find the Yazoo, on their return from a visit to the Natchez, massacring the small garrison of the French fort on the Yazoo river.

According to Du Pratz, the Yazoo and other small tribes, after the Natchez troubles with the French, took refuge with the Chickasaw and were absorbed by them.

B. F. French, however, says[1] there were still a few huts of the Yazoo on the Yazoo river so late as 1851.

A list of the small tribes of the lower Yazoo is given by Coxe,[2] and another by Chevalier Tonty,[3] who says: "The Yazous are masters of the soil."

Other lists are given by Du Pratz[4] and by Penicaut.[5] Referring to the Yazoo river at the beginning of the eighteenth century, La Harpe[6] says: "Cabins of the Yazous, Courois, Offagoula and Ouspie are dispersed over the country upon mounds of earth made with their own hands."

[1] Hist. Coll. of La., Part III, p. 59, footnote.
[2] French, Hist. Coll., of La., Part II, p. 227.
[3] *Ibid.*, Part I, p. 82, *et seq.*
[4] Histoire de la Louisiane, Paris, 1758, Vol. II, p. 226.
[5] Hist. Coll. of La. and Fla., 1869, p. 61.
[6] Hist. Coll. of La., Part III, p. 106.

There can be little doubt that in early times the Natchez-Yazoo region had a comparatively considerable population.

Du Pratz attributes the great falling off in numbers of the Natchez tribe in his time (1720) to the many human sacrifices following the death of the greater and inferior "suns," or nobles, which, he says, were more destructive than the havoc wrought by war.

But the Natchez had their wars also, for, although Charlevoix, speaking of them in 1721, says they rarely go to war and do not glory in the destruction of men, de Montigny, who saw them in 1699, speaks of them as then at war "with almost all the nations on the Mississippi."[1]

De la Vente,[2] who visited the lower Mississippi river in 1704, found most of the peoples there at war. "I could not say for how long back," he says, "their chief glory has been to take a few scalps from their enemies on the slightest pretext." M. de la Vente adds that the English gave the Indians firearms and incited them to make war on each other in order that they (the English) could obtain slaves thereby.

Parenthetically, it may be said that the English were not wholly to blame in the distribution of firearms. Of Indians of Mississippi we are told by Father Membré, who went down the Mississippi in 1682, that "they have also axes and guns, which they procure from the Spaniards, sixty-five or more leagues off."[3]

Presumably all the causes given were contributory to the lessening of the number of aborigines, to which may be added the introduction of smallpox and of alcoholic drink.

We shall now describe our work on the Yazoo and Sunflower rivers. As noted in previous memoirs, it is our practice to have agents, who are accustomed to the work, travel in advance over the region, the investigation of which we have in view, in order exactly to determine the situation of mounds and cemeteries, and to obtain the names and addresses of the owners; thus, in the winter season, in our flat-bottomed steamer, with a large force to dig, including many who have been in our service before, we go directly to work on such mounds, whose owners have accorded us permission.

Preceding our work, Mr. J. S. Raybon, captain of our steamer, who has traveled for a number of seasons to discover mounds for us, accompanied by a companion, carefully searched the Yazoo river from Sharkey to its union with the Mississippi, a distance of about 257 miles by water, and also covered the Sunflower from Faisonia to its junction with the Yazoo—about 96 miles, following the course of the stream.

After about one month's continuous work on the Yazoo and Sunflower rivers

[1] M. l'Abbé Amédée Gosselin, "Les Sauvages du Mississippi," Congrès International des Américanistes, Québec, 1906, Vol. I, p. 43.

[2] *Ibid.*, p. 43, *et seq.*

[3] B. F. French, Hist. Coll. of La. and Fla., New York, 1875, p. 25, footnote.

(January–February, 1908), it having become evident to us that our search was inadequately rewarded, we determined to change to another field, after having worked on the Yazoo river as far northward as Racetrack Landing, 187 miles by water above Vicksburg; and to George lake on the Sunflower river, 17 miles by river above its union with the Yazoo.

The Yazoo and Sunflower river region forms part of a great alluvial plain that is subject to overflow and is almost without high ground of any sort. Hence our investigation was greatly hampered, since permission to dig was refused in some instances, and restricted in many others, owing to the necessity for landowners to preserve their mounds for the use of cattle and hogs (and for the inhabitants on occasion) in periods of high water. The need to leave the mounds, therefore, in as good condition as that in which they were found and without involving any part of them which might be exposed to wash of water, accounts for many instances of incomplete investigation on our part.

Presumably, however, the result of our research was not materially affected by our limitations, as enough work was done, we think,[1] to prove the preponderance of domiciliary mounds in the Yazoo–Sunflower region and to show that the placing of artifacts with the dead was not widely practised there.

Two points of interest, however, were demonstrated by our work:

According to Du Pratz,[2] no tribe of Louisiana practised cremation—referring, of course, to the great region then known as Louisiana, of which the Yazoo territory formed a part.

As our report on the Yazoo country will show, cremation was practised there in aboriginal times. Hence we must conclude that the custom antedated the time of Du Pratz's sojourn in the region (1718 and later), or, which is more likely, that this author, though a careful observer, was not able accurately to report on all the customs of so extended a territory.

Another point determined by our work relates to urn-burial.

When we wrote our paper on "Urn-burial in the United States,"[3] we were unable to cite an instance of the discovery of an aboriginal urn-burial in Mississippi. Our work on the Yazoo shows it to have been practised there upon one occasion at least.

No skulls or other skeletal remains, in a condition to keep, were found by us in the Yazoo–Sunflower region.

We shall now proceed to describe our work in detail, first tendering the warm thanks of the Academy of Natural Sciences to all owners of mounds or of aboriginal dwelling-sites, who so kindly granted us permission to dig in a region where for reasons we have explained, the favor sometimes involved personal sacrifice.

[1] We will gladly transfer to any institution or to any responsible individual willing to undertake the work, all the data as to mounds, and letters of permission relating to that part of the Yazoo and Sunflower rivers covered by our agents, but not investigated by us.

[2] *Op. cit.*, Vol. III, p. 24.

[3] American Anthropologist, Oct.–Dec., 1904.

MOUNDS AND SITES INVESTIGATED ON THE YAZOO RIVER.

Mounds at King's Crossing, Warren County (3).
Dwelling-site below Haynes' Bluff Landing, Warren County.
Mounds near Haynes' Bluff Landing, Warren County (3).
Mounds near Leist Landing, Issaquena County (2).
Mounds near O'Neill's Landing, Yazoo County (2).
Mound near Stella Landing, Yazoo County.
Mound near Clark's Ferry, Yazoo County.
Dwelling-site near Monterey Landing, Yazoo County.
Mound at Caruthers' Landing, Yazoo County.
Dwelling-site at Koalunsa Landing, Yazoo County.
Mound near Parker's Bayou, Holmes County.
Mounds at the Fort Place, Yazoo County (5).
Mound near entrance of Tchula Lake, Holmes County.
Mound on Tchula Lake, Holmes County.
Mounds at the Peaster Place, Holmes County (4).
Mound at Belzona, Washington County.
Mound above Belzona, Holmes County.
Mound near Welsh Camp Landing, Holmes County.
Mound near entrance of Wasp Lake, Washington County.
Mounds near Wasp Lake, Washington County (6).
Mounds near Silent Shade Landing, Holmes County (2).
Mounds near Carey Middleton Gin Landing, Holmes County (2).
Mounds near head of Honey Island, Holmes County (2).
Mound near mouth of Yalobusha river, Leflore County.
Mounds on the Lucas Plantation, Leflore County (3).
Mound at Racetrack Landing, Leflore County.

MOUNDS AT KING'S CROSSING, WARREN COUNTY.

At King's Crossing, about four miles in a northerly direction from Vicksburg, in full view from the Yazoo and Mississippi Valley Railroad, are three mounds, and what may be parts of other mounds.

Mound A, on property belonging to Miss M. C. Collier, resident on the place, was used as a fortification by the Confederates during the siege of Vicksburg, and cannon-balls may still be seen partly imbedded in its clay.

Owing to the historical associations of the mound, the owner was unwilling that digging should alter its present shape; and in point of fact, investigation seemed almost unnecessary, inasmuch as the mound evidently belongs to the domiciliary class so abundant throughout southern United States.

At the time of our visit the mound was about 25 feet in height and showed much irregularity in shape, though doubtless formerly it had been a symmetrical oblong. Its basal measurements N. and S. and E. and W. were respectively 157

feet and 173 feet. The diameters of the summit plateau, in the same directions, were 74 feet and 92 feet.

Mound B, about 100 feet east of Mound A, on property of Mr. T. D. Major, residing nearby, was much spread by long cultivation.

Its height was 5 feet 5 inches; its base, of irregular outline, was 96 feet N. and S., and 84 feet E. and W. Fourteen trial-holes[1] were put into this mound (which probably was domiciliary), without result.

Nine trial-holes were dug without success into soil blackened with organic matter, somewhat to the north of the mound, evidently a former dwelling-site.

Mound C, about 250 feet E. by N. from Mound A, on property belonging to Miss Collier, has been almost cut to pieces—in the first place for use as a fortification, and later, it is said, by treasure seekers.

Dwelling-Site below Haynes' Bluff Landing, Warren County.

About one-half mile in a southerly direction from Haynes' Bluff Landing, on property belonging to Mr. Richard Harris, resident on the place, is a small dwelling-site in a cultivated field.

Investigation yielded nothing of interest with the exception of a neatly-made object of limestone, about the shape and size of a hen's egg, encircled somewhat above the middle by a groove (Fig. 1), which was found on the surface.

Fig. 1.—Object of limestone. Haynes' Bluff Landing. (Full size.

On Mr. Harris' property also are two elevations that were believed by persons in the neighborhood to be Indian mounds. Investigation, however, showed them to be ledges of lime-rock partly covered with soil, the stone being similar to that in the low hills about 150 yards distant.

Mounds near Haynes' Bluff Landing, Warren County.

On the plantation of Mr. H. K. Williams, resident on the place, about one half mile in a NE. direction from Haynes' Bluff Landing, on ground sloping toward the river, is a symmetrical mound, evidently domiciliary.

This mound, to some extent impaired by wash of water at its NE. angle, has a roadway leading out from its southern side.

Its height from the western side is 30 feet 2 inches; from the eastern side, 28 feet 5 inches.

[1] All trial holes mentioned in this report were designed to be 6 feet by 4 feet, by 4 feet deep. These dimensions, however, were not always strictly maintained.

The mound is practically square, the base being about 185 feet in each direction. The summit plateau is 75 feet square.

Fourteen trial-holes were put down, resulting in the discovery of a few fragments of bones of lower animals, mostly of the deer, and a bone which Prof. F. A. Lucas kindly has identified as being part of a tibia of a wild turkey. There were also some bits of earthenware, shell-tempered as a rule, a few having a fine black polish on each side.

In the neighborhood of this mound are three elevations, one of which we believe to be a knoll that has served as a dwelling-site; the other two, remnants of mounds.

In one of these, just below the surface, was a skeleton having small glass beads at the neck.

Mounds near Leist Landing, Issaquena County.

On the property of Mr. Samuel Leist, living on the place, are two mounds; an elevation in a field, probably a dwelling-site; and the remnant of a low mound, on which stands a house.

One of the mounds which, like so many in this region, serves as a refuge for cattle in flood-time, is about 400 yards in a westerly direction from Leist Landing.

Its height, taken from the eastern side, is 29 feet 4 inches.

Its basal outline is circular in a general way, but somewhat irregular owing to cultivation of the field in which it stands and to wash of water in times of overflow of the Yazoo. The sides of the mound also have been impaired through wash of rain and trampling of cattle in all probability, as the highest floods remembered have covered only the lower ten feet of the mound.

The diameter of the mound is about 174 feet. There is but little summit plateau.

Eleven trial-holes were put down in the upper part of the mound, the material encountered being hard loam.[1] These trial-holes were carefully filled by us according to our invariable custom.

With the exception of three recent burials in coffins, nothing was encountered by us in this mound.

On the bank of the Little Sunflower river, which here approaches the Yazoo, and about half a mile N. by W. from the mound just described, is a curious platform covered with loam filled with evidence of long occupancy, averaging 8 feet in height except at the southern end, where the elevation is 14 feet. Its outline is irregularly oblong. Its basal diameter N. and S. is about 305 feet; E. and W. it is 245 feet, approximately.

[1] The composition of the mounds of the Yazoo-Sunflower region is alluvial deposit, rich in clay, with the addition of more or less organic matter in places.

Fourteen trial-holes through dark loam to yellow clay below, showing the mound had been built and then lived upon, yielded no object of importance.

Mound near Miller Landing, Sharkey County.

A mound near Miller Landing was reported by our agent to be about 12 feet in height and about one acre in extent, but as several houses were upon it, investigation was impossible.

Mound near Sweet Home Landing, Yazoo County.

We did not visit a small mound reported to us as being near Sweet Home Landing, as permission to dig was not obtainable.

Mounds near Big Mound Landing and Sycamore Landing, Yazoo County.

These mounds, included in the list of our agent as near Big Mound Landing and Sycamore Landing, were not investigated by us, the owner explaining they were needed for protective purposes in times of overflow.

Mound near Friedlander Landing, Yazoo County.

A mound near Friedlander Landing was visited by us, but not opened, permission not being obtainable.

Mounds near O'Neill's Landing, Yazoo County.

On property of Mr. R. S. Coody, living on the place, in a cultivated field about one quarter mile from O'Neill's Landing, is a small circular mound 2 feet 6 inches in height and 33 feet in diameter.

Seven trial-holes to the base, were put down with negative result.

In woods one half mile in a northerly direction from O'Neill's Landing, also on property of Mr. Coody, was a circular mound 28 feet in diameter and 3 feet in height.

A small hole had been dug into the central part of the mound previous to our visit.

This mound was totally demolished by us, two bits of pottery being the only discovery made.

Mound near Stella Landing, Yazoo County.

On property of Mrs. H. L. Taylor, of Bentonia, Miss., in a cultivated field about 100 yards southwest from Stella Landing, is a symmetrical, conical mound 7 feet in height and 49 feet in diameter of base.

Two holes, 6 feet by 3 feet each, which were about all the limited summit plateau could accommodate, were put down and later were considerably enlarged by extending them under the slope.

From 4 feet 4 inches to 4 feet 10 inches down (the outer parts of the layer sloping downward) was a stratum of shells mingled with dry, clayey material, light brown in color. The thickness of this layer was not determined, a hole 1 foot 8 inches in depth not having reached the bottom.

A selection of the shells kindly has been identified by Dr. H. A. Pilsbry, as follows: *Quadrula trapezoïdes*, *Q. pustulosa*, *Q. lachrymosa*, *Q. trigona*, *Q. ellipsis*, *Lampsilis purpuratus*, *L. hydianus*, *L. fallaciosus*, *Viviparus subpurpureus*, *Pyramidula alternata*—all being shells found in the Yazoo region at the present time.

Sloping downward in the mound, the head being 3 feet from the surface, the knees, 4 feet 9 inches, was a skeleton of an adult, at full length, face downward, the head pointing west by north.

The beneficial effect of the infiltration of lime salts on bones was well illustrated in the case of this skeleton, which, down to the knees, was in a condition so friable as to fall almost into dust under slight pressure. From the knees down, however, the bones lay on the shell layer, of which mention has been made, and were hard and excellently preserved.

The tibiæ showed evidence of slight periostitis.

Under the same conditions as those of the burial just described, and interred in exactly the same manner, save that it headed WSW., lay another adult skeleton.

Neither of these skeletons had artifacts of any kind in association, except a fragment of pottery, which was probably an accidental introduction.

About 6 inches above the pelvis of one of the skeletons were the skull and some of the cervical vertebræ of a child. The remainder of this skeleton, probably little more than dust, had, no doubt, been thrown out in the digging without attracting attention. Around the neck were a number of shell beads.

In quest of a cemetery, twenty-four trial-holes from 1 foot to 2.5 feet in depth, as the case required, were put down without result in the neighborhood of the mound, through black soil showing former occupancy, to undisturbed clay.

Mounds near Enola Landing, Oak Valley Landing, Rialto Landing, Yazoo County.

We were unable to obtain permission to explore mounds reported by our agent to be in the neighborhood of Enola Landing, Oak Valley Landing, and Rialto Landing.

Mound near Tarsus Landing, Yazoo County.

A mound near Tarsus Landing, on property of Mr. John S. Hord, of Roseneath, Miss., was not visited by us, permission to dig having reached us after we had passed beyond the place.

Mounds near Yazoo City, Yazoo County.

A number of mounds near Yazoo City, which were kindly put at our disposal by their owners, Messrs. J. C. Hollingsworth and C. H. Clark, of that city, were not visited by us as we were informed by our agent, who had seen the mounds, that they had been dug into already ;[1] and the prospect for gleanings in the Yazoo region was not alluring.

Mound near Clark's Ferry, Yazoo County.

In a cultivated field belonging to Mr. E. T. Clark, living nearby, about one half mile WSW. from Clark's Ferry, in full view from the river, is a symmetrical, conical mound, 12 feet in height and 64 feet across the base. The summit plateau is 17 feet in diameter.

A deep hole, 6 feet by 5 feet, starting in the middle of the summit plateau, had been made at night, previous to our visit, presumably by treasure-seekers.

Two trial-holes, each carried to a depth of about 5 feet, produced only negative results.

In many parts of the field around the mound are deposits of broken shells, pebbles, fragments of implements, etc.—the usual debris of dwelling-sites. Fragments of coarse pottery were abundant; some of these bear cord-marked decoration, a few are colored with red pigment.

About 75 yards due south from the mound is a rise in the ground, thickly covered with broken shells and other debris. Twelve trial-holes put down to undisturbed soil yielded nothing of importance.

Dwelling-Site near Monterey Landing, Yazoo County.

In a corn-field about one half mile NE. from Monterey Landing, on property of Mr. M. R. Payne, of Koalunsa Landing, is much debris on the surface, denoting occupancy in aboriginal times. Fourteen trial-holes were without avail.

Mound at Caruthers' Landing, Yazoo County.

At Caruthers' Landing, on property belonging to Mr. J. S. Caruthers, of Yazoo City, is a mound in full view from the river bank. This mound, which forms part of a barn-yard, is 4 feet in height and 44 feet across its circular base. It has been much trampled by cattle, and is consequently spread and irregular in outline. Fourteen trial-holes resulted in the discovery of two arrowheads.

Dwelling-Site at Koalunsa Landing, Yazoo County.

At Koalunsa Landing is the residence of Mr. M. R. Payne, of whose property at Monterey Landing, mention has been made.

Immediately back of Mr. Payne's residence are shell deposits of considerable

[1] Probably the Champlin mounds described in Twelfth Ann. Rep. Bur. Am. Ethnol., p. 260, *et seq.*

extent, into which fourteen trial-holes were dug by us, resulting in the finding, in two places, of many human bones, which, lying just below the surface, gave evidence of having been scattered by the plow.

Mounds near Belle Prairie Landing and Beech Grove Landing, Yazoo County.

Our agent reported to us the presence of low mounds near Belle Prairie Landing and Beech Grove Landing, which we did not visit owing to inability to obtain permission to investigate.

Mound near Parker's Bayou, Holmes County.

In a cultivated field, about 1.25 miles in a northerly direction from Parker's Bayou, on property belonging to Mrs. Carrie W. James, of Yazoo City, adjacent to the barn-yard, is a mound 4 feet 7 inches in height and 64 feet across its irregularly circular base. Fourteen trial-holes gave no indication of human bones or of artifacts.

We were informed by tenants on this property that the mound had been erected "by the old master" in comparatively recent times, for the harboring of cattle in high water.

Mounds at the Fort Place, Yazoo County.

On the Fort Place, the property of Mr. W. B. Ricks, of Canton, Miss., is a large mound with a house upon it, in full view from the river banks. As this mound, we were informed, had been altered in shape to accommodate the house, no measurements of it were taken by us, nor was any digging in the mound attempted.

About 40 yards WNW. from the large mound, in a cultivated field, is a mound much spread by the plow, having at present a height of 3.8 feet and basal diameters of 108 feet and 66 feet. Seven trial-holes yielded nothing of interest.

About 65 yards SSW. from the large mound, in the same field, and evidently much reduced in height and somewhat increased in diameter by cultivation, is a mound 3 feet 4 inches high and 62 by 70 feet in diameter. Six trial-holes were without positive result.

A main road in front of the house has cut through two other mounds, leaving only remnants. These mounds, which evidently had been about the same size as the two in the field, are respectively 30 yards NNE. and 40 yards ESE. from the principal mound with the house upon it.

We have in connection with these mounds, a rather interesting feature. Each of the four corners of the principal mound is directed toward one of the surrounding mounds, perhaps indicating attention paid by the aborigines to the cardinal directions. The corner of the great mound, which is directed toward the mound ESE. of it, would be, in the winter time, about in the direction of the rising sun.

Mound near Entrance of Tchula Lake, Holmes County.

About 300 yards W. by N. from the landing on Honey island, at the mouth of Tchula lake,[1] in a cultivated field on property of Mr. Alfred Key, living nearby, is a mound 3 feet 8 inches high and 80 feet by 60 feet in diameter of base.

Thirteen trial-holes yielded neither bones nor artifacts, but in several cases they exposed deposits of musselshells which were too fragmentary for identification.

In the field in which the mound was situated were many bits of musselshells and other debris, denoting the former presence of aboriginal population.

From the surface came a fragment of an earthenware vessel, seemingly a platter, the inner face of which bears a decoration consisting of a band of bright red paint with alternate bands at right angles, showing red paint and the yellow of the ware. The pigment has been determined by Dr. H. F. Keller to be red oxide of iron.

Mound on Tchula Lake, Holmes County.

On the W. bank of Tchula lake, about three miles from its mouth, on property of Messrs. Wise Brothers, of Yazoo City, is a symmetrical mound 7.5 feet in height and 55 feet across its circular base. Three trial-holes of unusually large size were put down, this number being all the top of the mound would accommodate, the destruction of the sides not being desirable. The clay from which this mound was made was dry and hard, necessitating the use of a pick.

About 1 foot down were a few fragments of human bones; and 3 feet from the surface were bits of earthenware representing an entire pot, or a large part of one, with decoration resembling the impress of finger-nails.

Mounds at the Peaster Place, Holmes County.

On the Peaster Place, about 4 miles up, on the western side of Tchula lake, on property belonging to Mr. R. L. Peaster, of Thornton, Miss., are four aboriginal mounds.

Mound A, a symmetrical mound in sight of the bank of the old river, about 150 yards in an ESE. course from the landing, has a height of 9 feet 4 inches; a diameter at base of 58 feet.

A hole with perpendicular sides, 18 feet 6 inches long and 8 feet wide, was put down from the top of the mound. This excavation was 10 feet 6 inches deep in the middle, 10 feet deep at one end, and 9 feet in depth at the other end, which was under a sloping part of the mound, the excavation including more than the summit plateau.

The outer part of the mound consisted of a layer of loamy material, dark with admixture of organic matter, from 2 feet to 2.5 feet in thickness. Below this was a mixture—mainly clay—which continued until the base of the mound was reached,

[1] In many parts of the South what remains of the former course of a river is called a lake. Tchula lake was part of the Yazoo river in former times.

and owing to its hard and tenacious character required the aid of a pick to remove. This fact and the restricted space in which the diggers were confined made the work a veritable task.

Forty-seven burials were met with from just below the surface to a thin layer of dark material 9 feet down, on which were three fireplaces, one having fish-scales near it.

This layer, on which were scattered bits of musselshells and fragments of bones of lower animals, was probably the original surface of the ground. On this layer had been deposited a number of burials, but no trace of human remains was found below it, and the ground seemed undisturbed.

The human remains in this mound (with the exception of calcined fragments which, of course, were hardened by fire) were in the last stage of decay and with but two or three exceptions (which, strangely enough, came from near the base), could, even including the teeth, be readily reduced to dust between the thumb and finger.

The form of twenty-six burials was undetermined by us.

Certain burials will be considered in detail.

Burial No. 1, 1 foot 8 inches down, was a skeleton of an adult, lying at full length on the back, the skull SSW. This skeleton, from the skull to the pelvis inclusive, had lain on a bed of fire and the bones were badly affected by the heat, which had burnt the adjacent clay to a red hue.

Burial No. 2, 10 inches down, was an adult skeleton extended at length on the back, the head directed SE. This skeleton, from the upper part of the chest down to and including the feet, had lain on the same fire as skeleton No. 1, the legs of skeleton No. 2 crossing the chest of the other skeleton.

Although such parts of both these skeletons as had been exposed to heat showed markedly the effects of fire, the bones remained entire and were not reduced to small calcined fragments, as is the case when cremation among the aborigines has been successfully carried out.

Burial No. 5 consisted of the skeleton or of a large part of the skeleton of an adult, arranged in a bunch. Immediately above this bunch was a small layer of calcined fragments of bone which had belonged to a somewhat smaller skeleton than the one below it.

The foregoing burials, which were all superficial, it will be noted, were the only ones bearing marks of fire that were met with by us in this mound.

Burial No. 7 consisted of leg bones and a pelvis. We could not determine in this instance if the remainder of the skeleton had disappeared through decay or if no other bones had been interred. No trace of decayed bones was apparent, however.

Burial No. 9 was the skeleton of a child, probably flexed and lying on the left side.

Burial No. 11 was a bunch, though some of the related bones were attached when interred, as, for instance, a few of the lumbar vertebræ and the pelvis.

Burial No. 17. Nine feet down, that is to say on the base of the mound, lay the skeleton of an adult, the trunk on the back, the face turned to the right, the upper arms along the trunk. The right forearm was flexed up to the outer side of the humerus, with the hand turned in toward, and resting on, the shoulder; the left forearm was flexed up diagonally on the chest.

In addition there were the following burials:

Lying on the right side, closely flexed, one being a child,	9
Lying on the left side, closely flexed,	2
Closely flexed, face down,	1
Recent disturbances,	2

The skulls found in the mound showed no fixed orientation.

There were also throughout the mound scattered fragments of human bones and in several instances traces of decayed bones.

A fragment of a radius showed where the bone had healed with good union after a fracture.

Mainly with burials or where traces of burial remained, were a number of arrowheads or knives, and four lanceheads—all of chert. These points, with one exception, were rather rudely made, many showing breakage, thus leading one to believe that imperfect objects had been utilized for interment with the dead.

One lancepoint of dark gray chert, thin and carefully wrought, heart-shaped in outline, would be a fine example of aboriginal workmanship were it not for the absence of the point.

Lying with the burial was a "celt" 5.4 inches long, having a graceful flare on one side of the edge, though the flare was wanting on the other side. This hatchet was given to Mr. Peaster, owner of the mound.

The earthenware in this mound showed no evidence of shell-tempering, but was poor in quality, and when found was spongy from moisture and reduced to many fragments.

With a burial were parts of a vessel of moderate size, undecorated, which probably had been entire when deposited in the mound.

From near the surface came many fragments which, when put together, formed part of a vessel of yellow ware having as decoration a punctate field with ovals and oblong spaces decorated with red paint and surrounded by depressions so deep and broad that the designs had the appearance of being in relief.

A part of a vessel of inferior, dark ware, in many fragments, bore a rudely incised scroll-decoration.

Apparently dissociated was a small, undecorated pot which fell into many fragments on removal.

Mound B, in a cultivated field, about one mile from Mound A, in a SE. by E. direction, is 2 feet 7 inches high and 40 feet in diameter.

Eleven trial-holes were put down, some of which came upon human remains.

One foot down were bones not showing the effect of fire, though charcoal was immediately above them.

On the charcoal and extending beyond it was a deposit of calcined fragments of human bones, 2 feet wide, 2 feet 9 inches long, and about 3 inches thick.

Just below the surface of the mound was a thin layer of fragments of calcined human remains mingled with charcoal, 2 feet long by 1 foot 4 inches wide. Nearby was a small decorated pot in fragments. On the opposite side of the layer was another small pot, also in fragments, having a slight, rude decoration and two loop-handles.

Sixteen inches down were the remains of probably what had been a skeleton extended at full length on the back.

FIG. 2.—Vessel of earthenware. Mound D. Peaster Place. (Height 5.2 inches.)

Two feet from the surface was an urn-burial consisting of presumably a skeleton—the decaying remains of a skull and some long-bones being noted—which, after the removal of the flesh, had been taken apart and arranged in a heap on the ground. This heap had been covered, or rather, almost covered (for a few ends of long-bones projected), by a large inverted bowl of most inferior ware, which, upon removal, fell into many small fragments paste-like in consistency. This bowl had no decoration except a grotesque representation of a human head extending above the rim, part of which also crumbled away. Near the projecting bones was a small "celt" which was given by us to the owner of the mound.

A mingling of decayed skeletons was found 32 inches from the surface.

Mound C, about 95 yards SE. by E. from Mound B, was a circular rise of the ground, 2 feet 4 inches high and 40 feet in diameter. Eleven trial-holes produced only negative result.

Mound D is in a cultivated field, about one-half mile N. by W. from Mound A. Its height is 3 feet; its diameter, 83 feet. Nine trial-holes exposed two skeletons of adults, at full length on the back, parallel one to the other, the heads directed ESE. At the skull of one was an inverted vessel of inferior ware, badly broken, bearing an incised decoration (Fig. 2). On the other side of the head was part of a vessel in fragments.

Mounds at Holly Mound Landing and at Silver City, Yazoo County.

Large rectangular mounds with summit plateaus, evidently domiciliary, were inspected by us at Holly Mound Landing and at Silver City, but permission to investigate was not forthcoming.

Mound near Springwood Landing, Washington County.

A mound near Springwood Landing was reported by our agent but was not visited by us as the owner was unwilling to concede the privilege of digging.

Mound at Belzona, Washington County.

Visible from the river bank, about one quarter mile E. by N. from the landing at Belzona, is a mound, 11 feet in height, on property of Mr. M. Cohn, of that place.

This mound, whose longer sides are parallel to the river bank, which, at this place, is east and west, has a diameter of 165 feet by 125 feet. The summit plateau in the same directions, respectively, is 96 feet and 56 feet. Part of the eastern end of the mound has been hauled away in order to utilize the shell, a large admixture of which, mingled with dark loam, is present in the mound.

Twelve trial-holes put down in the summit plateau resulted in the finding of two fragments of a human femur in one instance and a human *os calcis* in another. Presumably these bones had been gathered with material for the construction of the mound.

One trial-hole exposed six post-holes in line, about 30 inches from the surface. These holes were from 3.5 to 4 inches in diameter and about 2 feet in depth. In another excavation were two similar post-holes.

No doubt an aboriginal building had once stood on a part of the mound before its final increase in height.

Mound above Belzona, Holmes County.

About 1 mile above Belzona, but on the opposite side of the river, immediately at the water's edge, on property of Mr. M. R. Payne, of Koalunsa Landing, Miss., whose kindness in permitting us to dig elsewhere on the river we have had occasion

to acknowledge, is a mound 5 feet 6 inches in height and 94 feet in diameter. Eleven trial-holes were sunk without result.

Mound near Welsh Camp Landing, Holmes County.

On property belonging to Messrs. L. G. and J. T. Montgomery, of Yazoo City, about three-quarters of a mile in a straight line SSE. from Welsh Camp Landing, though considerably farther by the road, at the edge of a swamp and in full view from the road, was a symmetrical mound, slightly furrowed in places by rain.

On the surface of this mound we picked up a small pottery vessel with a decoration probably made by trailing a broad point on the surface of the clay before firing. The decoration, however, had become rather indistinct through exposure.

Near the foot of the mound lay an arrowhead or knife, of chert, and an object probably of red sandstone, flat on one side, convex on the other, 3.75 inches in diameter and 1.5 inches thick.

The diameter of the base of the mound, which was circular, was 47 feet; the height as taken by us was 9 feet, but we are inclined to believe this figure exceeded the actual height, inasmuch as a perpendicular line from the summit plateau to undisturbed ground at the base proved to be but 7 feet 9 inches in length.

This mound, which was surrounded and practically dug down by us, but subsequently was rebuilt, was composed of soft, brown loam in the outer parts, but as the digging progressed hard and tenacious material was encountered, requiring time and much work to penetrate it.

What seemed to be the base of the mound was a line of black soil containing a few potsherds as well as fragments of bones of lower animals. Below it was undisturbed soil.

The first burial was encountered 16 feet from the center of the mound, and consisted of human teeth and a few fragments of bone in the last stage of decay.

In all, seventeen burials were met with, from 1 foot 9 inches to 8 feet 8 inches in depth, measured to the upper surface of the burials—those at the greatest depth being four skeletons in a circular grave at the center of the mound, 5 feet 8 inches in diameter and extending 1 foot 5 inches below the base.

These four skeletons, with skulls in three different directions, lay three on their left sides and one on the right side. Three were closely flexed, the knees being drawn up well toward the chin. One of the skeletons, flexed on the left side, had the legs at right angles to the body.

The skeletons, somewhat crushed, occupied a space 6 inches in thickness.

But one other grave below the base—a bunched burial or a much-detached skeleton—was found by us.

The predominating form of burial in this mound, where determination was possible, was that of close flexion, there being, in addition to the burials noted, four skeletons closely flexed on the right side, and two closely flexed on the left side. Moreover, two badly decayed skeletons indicated close flexion on the left side. There was also one bunched burial which may have been only a skeleton

rather more detached than the others, at the time of interment. One of the closely flexed skeletons lay with the mandible reversed.

There were also a burial disturbed in caved soil and one represented by traces of bone and teeth only. Probably others of this kind were passed over by us without notice.

The yield of artifacts from this mound, considering the initial discovery, was disappointing. With each of two burials lay a single arrowhead of chert, and sixteen lanceheads and arrowheads or knives, all of chert, but one which was of quartzite, none carefully made, lay singly throughout the mound, apart from burials.

In addition, also dissociated, a number of broken arrowheads or knives and a few small cutting implements, all of chert, were encountered.

There were in the mound also a number of small balls of compact, brown clay —possibly sun-dried—and several objects of the same material, diamond-shaped in section and evidently intentionally made.

Mound near Entrance of Wasp Lake, Washington County.

At the left side of Wasp lake, going in, about one-half mile in a westerly direction from the entrance to the lake, in a cultivated field belonging to Mr. S. H. McClintock, who lives on the place, is a small mound 3.5 feet high with circular base having a diameter of 48 feet.

Fourteen trial-holes brought no human remains to view, though two undecorated vessels of inferior ware, broken, were found separately in the mound.

These vessels were not shell-tempered, though the ware shows small patches on the surface, which, however, are somewhat darker than fragments of shell, and are not affected by acid.

Mounds near Wasp Lake, Washington County.

About five miles up Wasp lake, on the western side, somewhat less than a mile above Jaketown, are six mounds in the immediate neighborhood of the landing and a number of smaller mounds some distance away.

Although it was impossible for us to obtain permission to excavate these mounds, we spent some time in examining their surfaces.

Two are large, quadrangular mounds with summit plateaus and evidently domiciliary; one, a low flat mound; another through which a road has been cut; while two are mounds from 3 to 5 feet in height, which have been considerably reduced in diameter to make way for a railroad.

One of these mounds apparently had contained many burials, as fragments of human bones were scattered about and a large part of a skeleton lay exposed.

Spread over the neighboring field were many fragments of shell and numerous bits of earthenware, some of the latter shell-tempered and some not. Nearly all were undecorated, though some bore a beautiful, bright red pigment on both sides. The coloring matter on one of these, tested by Dr. H. F. Keller, proved to be red oxide of iron.

At the base of the cuttings of the two mounds through which the railroad passes, were quantities of fragments of pottery, some shell-tempered and some of the same sort of inferior, porous ware we had found farther down the river.

Mounds near Silent Shade Landing, Holmes County.

Somewhat less than two miles in, along the Tchula road from Silent Shade Landing, in full view from the highway, are two mounds within a few feet of each other.

Mound A, the northernmore, on property belonging to Mr. Robert E. Warfield, of Tchula, Miss., is 5 feet 7 inches high and 50 feet in diameter.

An excavation was made by us, 16 feet by 10 feet, with perpendicular walls, extending through a dark line with light-colored clay below. This clay, which we considered to be the base, was somewhat deeper than the height of the mound measured from the outside.

As usual, the outer part of the mound proved to be soft, the inner part hard and tenacious.

Considering this mound to have been built for burial purposes (and we do not see how the reverse can be possible), one cannot fail to be impressed by the small number of interments in so large a central portion—only seven having been encountered.

Four burials came from near the surface: two bunched burials; one probably a bunch; one too badly decayed to determine.

Nineteen inches down was a deposit of calcined fragments of human bones, 22 inches by 15 inches by 5 inches thick. On top of part of this deposit was a small, undecorated bowl of inferior ware, in fragments.

Two skeletons at full length on the back, almost in a condition to crumble into dust, lay, side by side, 3 feet 8 inches down, the heads directed SW.

Near the skull of one were two small, undecorated vessels of ordinary shape, and of inferior, porous ware, both in fragments. With these vessels were two hammer-stones.

The second skeleton also had near the skull a vessel similar to the others.

On the chest, in contact with the chin, was an ornament of wood, rotten through and through, which had been coated with sheet-copper, a few fragments of which still adhered. This ornament, circular, flat on one side and convex on the other, had a diameter of 2.5 inches, a thickness of .75 of an inch.

Near the surface of the mound were two undecorated pots of crude ware, found in fragments, separately, apart from human remains.

No earthenware from this mound showed tempering with shell.

Mound B, on property of Mr. S. S. Hudson, of Vicksburg, Miss., has a basal diameter of 46 feet. Its height is 4 feet 10 inches.

An excavation with perpendicular walls, 10.5 feet by 10 feet, and 5 feet 7 inches in depth, was sunk in the central part of the mound. No basal line was

encountered, though a hole of additional depth was made, extending into seemingly undisturbed soil. Ten inches below the surface was a layer of bones so badly decayed that the method of burial was past determination.

With this layer, together, were a small, undecorated bowl in fragments and a badly crushed vessel also without decoration.

At another part of this layer of bones were two other vessels, both badly broken. None of these vessels was tempered with shell.

Three feet 4 inches from the surface was a badly decayed burial which evidently had been at full length on the back.

Mounds near Carey Middleton Gin Landing, Holmes County.

About one-half mile ESE. from the landing at the Carey Middleton gin, though somewhat farther by the road it is necessary to take in the rainy season, on property of Mr. Carey Middleton, who lives on the place, are two mounds in a cultivated field, about three hundred yards apart.

Mound A, 6 feet 3 inches in height, much spread by cultivation, has a diameter of 64 feet.

A hole 9 feet by 12 feet was carried squarely down through a dark line of soil into undisturbed ground below.

One foot down was a bunched burial of badly decayed bones.

Slightly lower was a skull indicated mainly by remnants of teeth.

Mound B, NE. by N. from Mound A, is 5 feet 10 inches high and has a present diameter of 60 feet, much of which has been caused by the cultivation of the mound.

An excavation 9 feet by 11 feet, carried perpendicularly down, was made to a depth of somewhat more than 6 feet.

Eighteen inches down was a layer of fragments of calcined human bones, 30 inches by 24 inches and 2 inches thick. Mixed with these fragments was burnt clay but no ashes or charcoal, which indicated that the cremation had been conducted elsewhere.

Three feet down were human bones too badly decayed to show the method of burial.

The closely flexed skeleton of an adult, lying on the right side, was 3 feet 8 inches below the surface.

Not far from the Carey Middleton mounds is another which our agent informs us is somewhat larger than the ones investigated by us. This mound, belonging to another person, was not placed at our disposal.

Mound near Montgomery Landing, Holmes County.

Our agent reported to us a mound near Montgomery Landing, which we did not visit, not having been able to obtain permission to dig.

Mounds near the Head of Honey Island, Holmes County.

Near the head of the Yazoo river side of Honey island is the plantation of Mr. A. W. Evans, who resides on the place. The lower part of this plantation is known as Gold-dust. About half a mile in a NE. by E. direction from the landing at Gold-dust are two mounds in a cultivated field, in full view of each other, both much spread by cultivation.

One, largely of sand, has a height of 4 feet 4 inches and diameters of 78 feet and 64 feet.

The other mound, partly of sand, 2 feet 10 inches high, with diameters of 38 feet and 54 feet, has, somewhat below the surface, a great deposit of musselshells, mostly badly crushed. Some less broken than the rest have kindly been determined by Dr. H. A. Pilsbry as *Quadrula pyramidata*, *Q. plicata*, *Lampsilis fallaciosus*, all shell-fish still found in the Mississippi valley.

Mound near Sheppardtown Landing, Leflore County.

Two mounds near Sheppardtown Landing, described by our agent as visited by him, were passed by us without a visit, permission to dig not having been obtained.

Mounds near Shell Bluff Landing, Leflore County.

There are a number of mounds near Shell Bluff Landing, on properties belonging to Messrs. W. G. Poindexter, of Sheppardtown, Miss., and F. M. Southworth, residing on his property at Phillipston. Although both these gentlemen gave cordial permission to investigate, we did not avail ourselves of their kindness as the mounds which were inspected by us so nearly resembled others in which we had been unsuccessful that we decided not to delay our journey.

Mounds near Phillipston Landing, Leflore County.

Two small mounds near Phillipston Landing, on property belonging to Mr. F. M. Southworth, to whose plantation at Shell Bluff Landing we have already referred, were not investigated by us for the same reason that those at Shell Bluff Landing were not dug into, though Mr. Southworth had kindly placed the Phillipston mounds at our disposal.

Mounds near Oakwood, or Roebuck, Landing, Leflore County.

Two mounds near Oakwood, or Roebuck, Landing, belonging to Mr. Herman Aron, of New Orleans, La., were not visited by us owing to the unsatisfactory return from mounds in this region, though Mr. Aron had willingly given his consent to our work.

Mound near Mouth of Yalobusha River, Leflore County.

On property of Mr. S. J. Stein, of Greenwood, Miss., at the roadside, about one quarter mile NNE. from the landing, at the union of the Yalobusha, an

unnavigable stream, and the Yazoo river, is a mound almost circular in basal outline, with a diameter of 46 feet. The height of the mound is 3.5 feet. A central excavation 10.5 feet by 8.5 feet by 4 feet deep yielded neither bone nor artifact.

Mound near Ashwood Landing, Leflore County.

In a cultivated field, a short distance from Ashwood Landing, on property belonging to Mr. W. C. George, of Greenwood, Miss., is part of a mound, the remainder having disappeared through cultivation and through wash of rain. Although Mr. George had consented to investigation of the mound, we decided the work would be inexpedient.

Mounds near Star West Landing, Leflore County.

Two small mounds, said by our agent to be about 1.5 miles from Star West Landing, were not dug into, although their owner, Mr. F. M. Aldridge, of Greenwood, Miss., had courteously authorized the investigation.

Mounds on the Lucas Plantation, Leflore County.

On the plantation of Dr. J. H. Lucas, of Greenwood, Miss., about 5 miles above Greenwood, on the west side of the river, all in sight from the bank, are three mounds.

The northernmost is a remnant immediately on the bank.

The next, in a cultivated field, has a small modern cemetery upon it.

The third, in the same field, much spread by plowing, is 6 feet 4 inches in height, and 82 feet across its circular base. Fourteen trial-holes were sunk without result.

Mound at Racetrack Landing, Leflore County.

In sight from Racetrack Landing, on property of Mr. S. F. Jones, resident on the place, is a mound with irregularly circular base, 107 feet in diameter, and 20 feet across the circular summit plateau.

The mound, though furrowed by rain and somewhat cut by cultivation at the base, is still symmetrical, and being 24 feet in height, presents an imposing appearance.

Three trial-holes in the summit plateau, each 5 feet in depth, were without result.

On our way up the river our hopes had been buoyed by reports which our agent had heard of a carved vessel of stone, with a top of like material, which, it was said, had been taken from the mound at this place.

Our agent had visited the mound in the absence of the owner, and hence had been unable to investigate the report.

The rumor turned out to be without any basis whatsoever, nothing, we were assured by Mr. Jones, having been taken from the mound.

At this point on the Yazoo river, there being no report from mounds farther up to justify hope of greater success in returns, the investigation of the river banks and the adjacent territory was abandoned by us, although, as we have said, abundant work had been mapped out by our agent as far as Sharkey, about 70 miles above by water.

MOUNDS AND SITES INVESTIGATED ON THE SUNFLOWER RIVER.

Mound near Anderson Landing, Sharkey County.
Mound near Bachelor Retreat Landing, Sharkey County.
Mounds near Wrong-end-up Landing, Yazoo County (3).
Mounds at Spanish Fort Landing, Sharkey County (3).
Mound at Fairview Landing, Yazoo County.
Mound on Fairview Plantation, Yazoo County.
Mounds at Stalonia Landing, Sharkey County (3).
Mounds near George Lake, Yazoo County (a large group).

Mound near Anderson Landing, Sharkey County.

In woods about one-quarter mile E. by S. from Anderson Landing, on property probably belonging to Messrs. George T. Houston & Co., of Chicago, Ill., to whom the Academy is especially indebted for the fullest and most cordial permission to excavate all mounds on the great territory owned by them, on the Sunflower river, and for kind offers to facilitate its work in every possible way, is a mound 6 feet 7 inches in height and 62 feet across its circular base.

This mound, which gave evidence of former, but apparently somewhat superficial, investigation, was dug out by us in the central part, the excavation being 7 feet 6 inches, by 12 feet, by 7 feet 4 inches deep, the sides of the hole being carried squarely down.

Near the surface were disturbed human bones with which were fragments of a vessel of yellow ware without shell-tempering. This vessel (No. 1), whose parts have been put together, has a quadrilateral body with rounded corners, on which is a decoration partly punctate and partly produced by the trailing of a broad-pointed implement. Below the upper margin of the vessel is a circular band of evenly made, reticulated lines, and an encircling line of imprints, made with the end of a blunt tool (Fig. 3).

About 3 feet 9 inches from the surface was a small, undecorated bowl of dark ware (Vessel No. 2), in fragments, with mere traces of a skull and teeth nearby.

Six feet 9 inches down, presumably on the base of the mound, near what were probably traces of human bones, was Vessel No. 3, in fragments (Fig. 4). The yellow ware is without shell-tempering. Below the rim is a rude, cross-hatch decoration, while the body of the vessel has a primitive, trailed design, three times represented, showing a serpent (Fig. 5).

While we were engaged on other and more superficial work in the mound, an undecorated vessel in small fragments was encountered.

FIG. 3.—Vessel No. 1. Anderson Landing. (Height 3.25 inches.)

FIG. 4.—Vessel No. 3. Anderson Landing. (Height 3.9 inches.)

Mound at Pecan Grove, Sharkey County.

This mound, which was kindly placed at our disposal by Mr. T. H. Campbell, Jr., of Yazoo City, was not dug into by us owing to the presence of a building on it.

Mound near Bachelor Retreat Landing, Sharkey County.

By the roadside, in sight from Bachelor Retreat Landing, on property of Mr. John Ross, who lives at the landing, is a mound much worn by cattle and washed by rain and by the river in times of overflow. The present diameter of the circular base of the mound is 60 feet; its height is 3 feet 7 inches.

Fourteen trial-holes resulted in the discovery of decaying human bones just below the surface, and of what appeared to indicate a bunched burial, 2 feet 8 inches down.

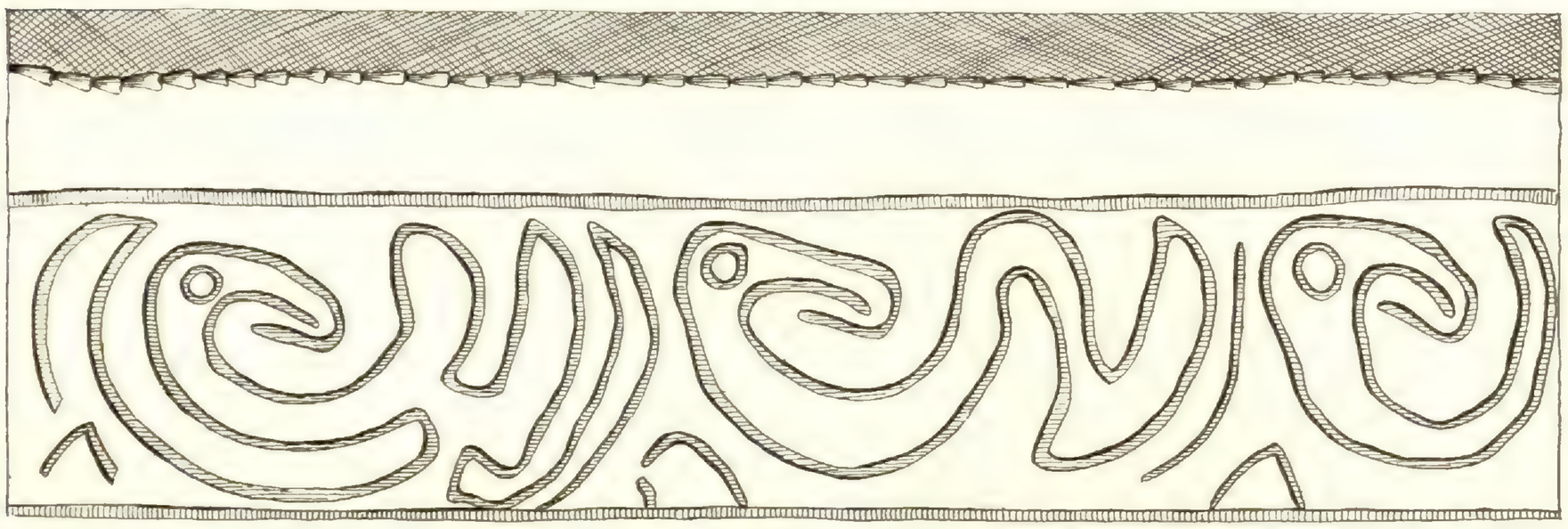


Fig. 5.—Vessel No. 3. Decoration. (Half size.)

Mounds near Wrong-End-Up Landing, Yazoo County.

In woods about three-quarters of a mile in an easterly direction from Wrong-end-up Landing, on property of Mrs. J. E. Edwards, whose address we were unable to learn, is a mound with circular base and summit plateau, whose diameters are, respectively, 72 feet and 28 feet. Its height is 7 feet 9 inches.

Nine holes were dug into the summit plateau and into the sides of the mound, four being ordinary trial-holes, and five considerably larger.

Nearly 4 feet down were remains of a badly decayed skeleton.

In another hole, 3 feet from the surface, were a number of bones crushed together, greatly decayed, including three skulls indicated by remains of teeth.

Two other mounds about one-quarter mile in a northwesterly direction from the one just described, served as foundations for pens for domestic animals in flood-time and were not dug into by us.

Mounds at Spanish Fort Landing, Sharkey County.

Visible from Spanish Fort Landing are three mounds, upon one of which is a house; upon another, a cotton-gin.

A few yards from the gin, in a cultivated field, on property of Mrs. L. A. Kettleman, living nearby, is a circular rise of the ground, evidently a dwelling-site as its surface is thickly strewn with bits of pottery and fragments of musselshells. Considerable digging in this place was without return.

The field in which this dwelling-site is, having an area of forty-five acres, it is said, is enclosed, except that part which faces the river, by a semi-circular embankment resembling a levee. It is from this embankment, which we believe to be aboriginal, like similar enclosures in this region, that the landing takes its name.

Mounds at Fairview Landing, Yazoo County.

In sight from Fairview Landing, on property of Mr. William G. Childers, of Satartia, Miss., in a cultivated field, are three mounds in line, but short distances apart.

The largest, much spread, had been considerably dug into previous to our visit, and the smallest mound is in use as a cemetery. Neither of these mounds was dug into by us.

The third mound, lying between the other two, is conical and fairly symmetrical. Its height is 11 feet 6 inches; its basal diameter, 75 feet. A moderate amount of digging in this mound showed that it, too, had been used as a cemetery in recent times.

Near Fairview Landing is a mound belonging to Mr. S. S. Hearn, of Wrong-end-up Landing, which we did not investigate owing to the presence of a house upon it.

Mound on Fairview Plantation, Yazoo County.

In sight from an arm of the river that here encircles a small island, at the upper end of Fairview plantation, partly cut away by the road, is a small mound also belonging to Mr. S. S. Hearn. The height of this mound is 3 feet; its diameter, 35 feet. Our investigation was unrewarded.

Mounds near Maybon Landing, Yazoo County.

Two mounds reported by our agent as near Maybon Landing were not visited by us, permission to dig not being forthcoming.

Mounds at Stalonia Landing, Sharkey County.

On property of Mrs. N. J. Guess, living nearby, at Stalonia Landing, are three mounds, one of which, much cut away by a railroad, shows no bones or artifacts along the section.

The other two mounds are in a cultivated field just beyond the landing.

One of these, almost plowed away, was dug into by us without success.

The third mound, well preserved, evidently domiciliary, has a height of 9 feet. Its basal length NNE. and SSW. is 128 feet; and 103 feet SE. by E. and NW. by W. The diameters of the summit plateau in the same directions, respectively, are 64 feet and 43 feet.

Considerable digging in this mound yielded only a small, flat mass of limestone, pitted on one side.

Mounds at the Mouth of George Lake, Yazoo County.

Two small mounds at the mouth of George lake, southern side, were visited by us but were not investigated, though permission had been given by Mrs. C. E. Crippen, their owner, who lives nearby.

Mounds near George Lake, Yazoo County.

About one-half mile above the union of George lake[1] with the Sunflower river, on the southern side of the lake, on the plantation of Mr. W. A. Henry, of Yazoo City, Miss., to whom the Academy is especially indebted for full permission to investigate, is a notable group of mounds.[2]

These mounds, rising here and there around a great central tumulus, stud an area of about forty-four acres, as determined by a recent survey, we are informed.

Here and there pools of water mark excavations whence material for the mounds was taken.

The mounds are enclosed, except on the lake-front, by an aboriginal embankment, probably from 4 to 6 feet in height, and no doubt of greater altitude in early times. Possibly it was then surmounted by a stockade.

The number of mounds that surround the great central one in a rather irregular way would be hard to determine with exactness, inasmuch as but two of the entire group have not been subjected to cultivation over the entire surface, and some, probably never of great size, are now hardly distinguishable. Presumably more than thirty rises of the ground and mounds small and great could be counted within the enclosure.

Of all these mounds, however, but three retain any resemblance to their former shape, supposing them to have been other than mere conical elevations; and one of these three (now with a well-marked summit plateau), cultivated over its entire surface, its soft material exposed to wash of heavy rains, will soon be in the condition of most of its companions.

The most symmetrical mounds and the only ones (except the one we have noted as in process of destruction) that are not of moderate height, are the great central mound and another about 80 yards in a southwesterly direction from it.

The great central mound (whose sides almost exactly face the cardinal points),

[1] The reader will recall that a "lake" in this region, is where the river formerly flowed but has been diverted from its course.

[2] This land, being somewhat elevated, is usually beyond reach of the river, though it is covered in times of very high water, as was the case in the great overflow of 1882, when the inhabitants and their stock, from a considerable distance around found these mounds a welcome place of refuge.

with remnants of causeways on the E. and N., is now almost devoid of vegetation; and trampled by animals and with the soil of the summit plateau loosened by cultivation and offering full scope to wash of rains, which have eaten narrow channels[1] into the sides of the mound, has lost much of the symmetry it possessed until recently, and soon, we fear, will be still farther impaired.

The height of this mound is 55 feet, as taken by us from near the base. We were informed, however, that a surveyor, standing at some distance from the mound, had determined its height to be more than 60 feet.

It seemed to us, however, that the standpoint of the surveyor, as pointed out to us, was somewhat below the general level, a pool of water being there at the time of our visit. Perhaps a fair judgment of the height of the mound would be midway between the figures given by the surveyor and our own, as possibly we stood somewhat on the slope when our determination was made.

The western part of the summit plateau, 57 feet in length, is about 9 feet lower than the eastern 42 feet—the total diameter of the plateau E. and W. being 99 feet. In a N. and S. direction the diameter is 93 feet.

The basal diameters of the mound are 263 feet E. and W., and 275 feet N. and S. Doubtless the mound, at one time, was practically square in horizontal section.

The mound to which we have referred as southwesterly from the great mound is a truncated cone 22 feet in height, about 173 feet in diameter of base and 86 feet across its summit plateau. The remains of a causeway are apparent on the northern side.

Strewn over the enclosed area, among the mounds and on them, in some places in great abundance, are chert pebbles; fragments of chert; bits of musselshell; and small parts of earthenware vessels.

The ware, as a rule undecorated, is shell-tempered in most instances but sometimes has a tempering of small fragments of stone which does not react to acid, such as is often found in the ware of the Yazoo–Sunflower region.

The decoration, when present, so far as noted by us, offers no original feature. Mr. J. B. Martin, manager of the plantation, to whom we are indebted for much information as to the place, showed us a small water-bottle of excellent, yellow, shell-tempered ware, with a graceful decoration consisting of a current scroll and small circle, four times repeated, boldly executed with a broad, trailing-point. This vessel, Mr. Martin said, had been found in digging a post-hole on the property.

There were found on the surface by members of our party, several small, delicately-shaped arrowheads of chert; part of a diminutive chisel apparently of silicified wood; a ball of chert, from 2.75 inches to 3.5 inches in diameter. This ball, which has depressions on two opposite sides as for fingers, perhaps served as a hammer-stone. We read, however, in the Narrative of d'Iberville[2] of "a round stone ball which they strike with sticks" for amusement.

[1] One at least reaching a depth of 5 feet.
[2] French, Hist. Coll. La. and Fla., 1875, p. 74.

We found on the surface of a low mound, a pipe of earthenware, probably representing a wolf or a dog (Fig. 6). The ware is shell-tempered; the modeling, without artistic merit.

Thirteen trial-holes sunk into the mound on which this pipe lay were without reward.

We did but a moderate amount of digging on and among the mounds near George lake, finding two burials lying near the surface, which had undergone disturbance.

There was little inducement to dig, as superficial burials, had there ever been

FIG. 6.—Pipe of earthenware. Mound near George Lake. (Full size.)

any, in summit plateaus of the mounds must have been long since plowed and washed away, and the same conditions, no doubt, largely existed in the level ground.

Such other mounds as were investigated yielded nothing.

Another discouraging feature was the almost entire absence of history of the discovery of bones or of artifacts on the plantation, despite deep and constant cultivation and wash of rain, through which the level ground in places, as well as the mounds, is deeply furrowed.

At George lake our journey up the Sunflower river was abandoned, although, as we have said, the stream had been reconnoitered by our agents as far as Faisonia, 79 miles above, by water.

PART III

THE BLUM MOUNDS, MISSISSIPPI

BY

CLARENCE B. MOORE.

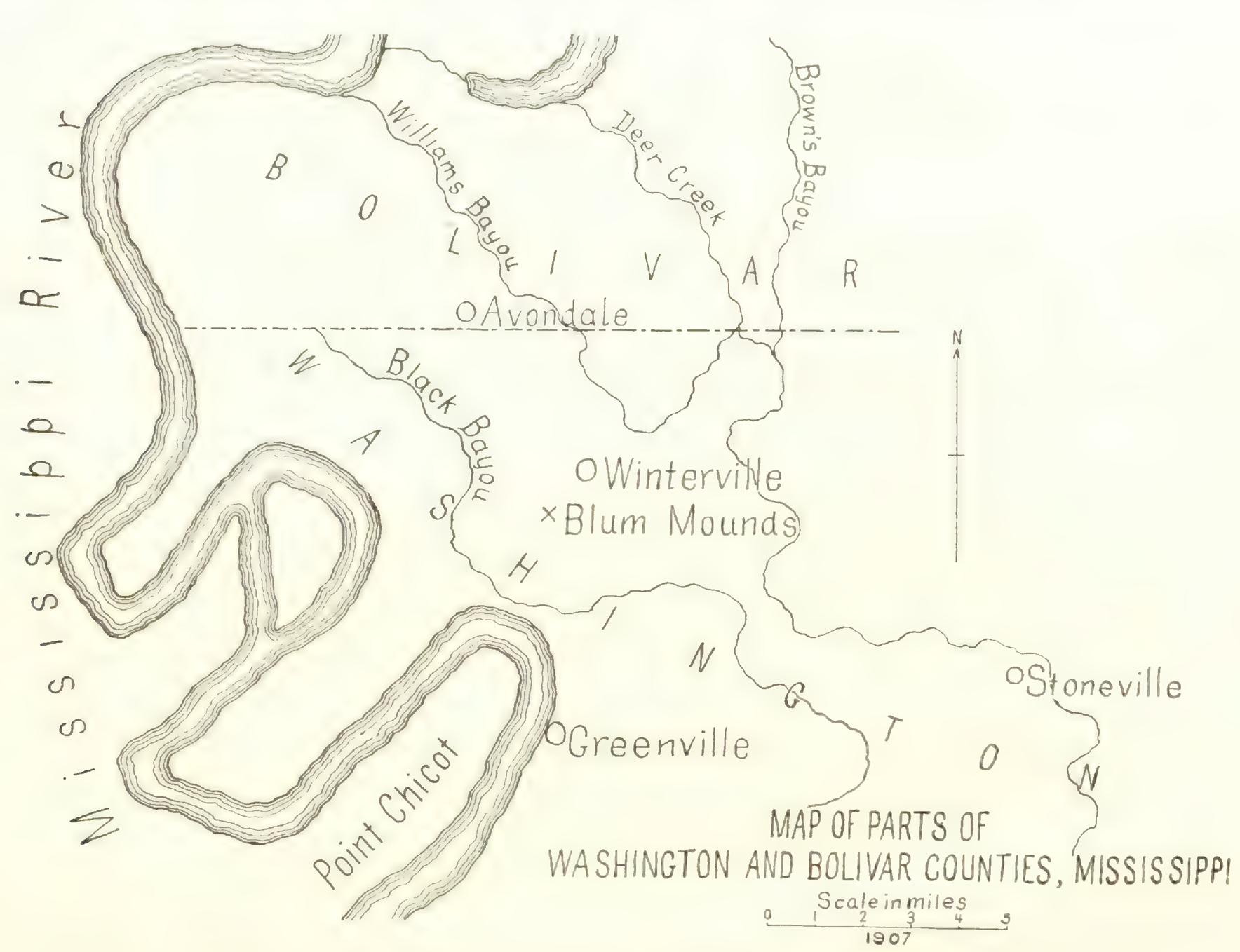
CERTAIN MOUNDS OF ARKANSAS AND OF MISSISSIPPI.

By Clarence B. Moore.

PART III.

The Blum Mounds, Mississippi.

The Blum group of mounds, in Washington county, Miss. (see map), is about four miles in a straight line, in a northerly direction from the city of Greenville; about one mile in a southerly direction from Winterville station; and two miles NNE. from the Mississippi river at its nearest approach.



The group on a plantation belonging to A. Blum, Esq., of Greenville, Miss., and of New Orleans, La., to whom the warm thanks[1] of the Academy of Natural

[1] The Academy wishes also to express its indebtedness to Messrs. J. B. Williams, Esq., of Greenville, the lessee of the property, and J. H. McKnight, Esq., of Winterville, the superintendent.

C
B
D
O
A
E
N
F
M
G
L
H
N
BLUM MOUNDS
NEAR WINTERVILLE, WASHINGTON COUNTY, MISSISSIPPI
Scale in feet
0 50 100 200
1907
I
K
J

Sciences are tendered for full and cordial permission to investigate, consists of a great central mound, 55 feet high, surrounded by fourteen other mounds forming an irregular ellipse. One of these mounds is so nearly obliterated, however, that it might well be passed over in an enumeration.

The diameters of this ellipse are about 1600 feet NE. and SW., and 1000 feet NW. and SE.

The central mound, marked A, and the other mounds marked B to O, inclusive, are shown in the accompanying plat of a survey[1] made by Dr. M. G. Miller, at the time of our visit.

Certain small elevations outside and inside the ellipse, probably dwelling-sites, have been disregarded in the plan.

The Blum mounds, uninvestigated previous to our visit, though a few holes had been dug into them (by treasure-seekers, it is said), are not mentioned in the "Mound Reports" of the "Twelfth Annual Report of the Bureau of American Ethnology."

They are not the "Avondale Mounds" referred to in the "Twelfth Annual Report" and in Thomas' "Catalogue of Prehistoric Works," but are unquestionably the group described in the latter work as being "nearly opposite Point Chicot," which group is more fully described in the Smithsonian Report for 1879, page 383 *et seq.*, though the plan accompanying the description gives but little idea of the mounds as they appear at present.

These mounds on the river plain and, consequently, on land subject to overflow, are not, however, exposed to wash of water in time of flood, it is said, the distance from the river being such that the current has no influence, and the water consequently is still.

The summits of the more important mounds of the group, so far as known, have never been submerged, the usual rise of water about the mounds when there is a flood being, we are told, from 3 to 5 feet.

Nevertheless, a number of the mounds (E, F, G, H, I, K, L, M, N, O) have no regularity of outline, a fact due, we believe, to long-continued cultivation, though some of the mounds enumerated have not been plowed over in comparatively recent times.

Even the regularity of most of the larger mounds, the sides of which are too steep for cultivation, is considerably impaired, owing, probably, to wash of rain; to the constant tread of mules, sheep, goats, and hogs, which frequent the mounds in numbers; to the deep and extensive rooting of hogs; and to the general wear and tear of time, which is ever more destructive in the case of mounds like the Blum mounds which are but little protected by the roots of trees and shrubbery.

It might be suggested that in earlier times, before the erection of the levee, different conditions tending to make stronger the erosive force of the water, may

[1] Though the expedition was amply provided with photographic apparatus, no photographs of the mounds were made. Experience has shown that the work of the camera in connection with mounds is misleading, undue prominence to the foreground being given and inadequate portrayal of the heights.

have existed, or that the mounds may have been much nearer the river (which, as all know, is ever changing its course) and were exposed in flood time to a deeper and fiercer current than is the case at present.

The answer to this would be that Mound J (which is protected by bushes and shrubbery, and does not seem to be frequented by stock) is almost intact, and that this mound has suffered only to the extent of a partial leveling of its causeway, evidently through cultivation.

A current that would wash away any of the mounds, presumably would eat into all of them.

The height of a mound often depends on the side from which the measurement is made. The subjoined list gives the altitudes of the Blum mounds, as taken from within the enclosure.

Mound A—55 feet.
Mound B—13 feet 2 inches.
Mound C—19 feet 6 inches.
Mound D—17 feet 6 inches.
Mound E— 6 feet 7 inches.
Mound F— 9 feet 7 inches.
Mound G— 4 feet.
Mound H— 7 feet 7 inches.
Mound I— 9 feet.
Mound J—30 feet 10 inches.
Mound K—12 feet 5 inches.
Mound L— 7 feet 6 inches.
Mound M— 7 feet 3 inches.
Mound N— 8 feet.
Mound O—10 feet 10 inches.

The Blum mounds and surrounding territory have comparatively no history as to the discovery of artifacts or of human remains. No human bones were seen by us on the surface, though extensive ditching had been done, and much of the level ground and a number of the mounds are regularly plowed over; and only a limited number of fragments of earthenware lay around—all this lack of signs of former occupancy being in marked contrast with our experience at the great group of mounds at Moundville, Ala.

Six days in November and December, 1907, were devoted by us to the Blum mounds, with five of our trained men to dig, it being impossible to engage additional help at the mounds owing to scarcity of men on account of the needs of the cotton-crop. However, as it turned out, a greater force was not urgently called for.

A very long experience in mound-work in southern United States has led us to believe that domiciliary mounds and mounds built as places of worship (which classes of mounds are of considerable size and usually are rectangular in outline with summit plateaus) seldom contain burials. We know, however, there are noteworthy exceptions to this rule, some of which we have enumerated at length

in the account of our first visit to Moundville,[1] and that summit plateaus or parts of them sometimes were used for burial purposes.

We commenced, then, to investigate the Blum group of mounds in the same manner as we did the mounds and cemeteries of Moundville, namely, by sinking trial-holes in the summit plateaus of the mounds, and in the level ground where appearances indicated the possible presence of a cemetery, with the intention, should burials be discovered, of prosecuting the search in a more thorough way.

The trial-holes in the Blum mounds were intended to be 6 feet long by 3 feet wide and 4 feet deep, but as the material of which the mounds were made was, as a rule, a tenacious, alluvial deposit, dried comparatively hard and in places still farther hardened by fire, necessitating the use of picks and grubbing-hoes, the dimensions given were not always adhered to exactly. Sometimes, but not often, the holes exceeded the standard size.

In the level ground the trial-holes were 6 feet by 3 feet and were usually 4 feet deep, but sometimes when ground unmistakably undisturbed was reached, the holes were not carried to a full depth of 4 feet.

We shall now state the extent of the tentative work carried on by us in connection with the Blum mounds, giving the area of each summit plateau where such was present.

Mound A, summit plateau 100 feet by 132 feet, approximately, was accorded twelve trial-holes on the summit plateau and five at its northern corner.

Mound B, with a summit plateau 44 feet by 60 feet, had on it a number of burials made in recent times, which were not disturbed by us. But five trial-holes were put down in this mound.

Mound C, with a summit plateau of irregular outline, 90 feet by 136 feet, received five trial-holes.

Mound D, with an irregular, oblong plateau about 60 feet by 112 feet, was fairly well covered by the seven trial-holes allotted to it. In one hole, just below the surface, was an isolated skull badly decayed. In another were fragments of a skull.

Mound E, part of which had been cut away in the making of a road, received one trial-hole in addition to a close examination of the section laid bare.

Mound F, four trial-holes. A small oblate-spheroidal vessel of coarse ware was found near the surface.

Mound G, five trial-holes. Lying near together in this mound were nine double-pointed fish-scales which Mr. H. W. Fowler, of the Academy of Natural Sciences, has identified as probably belonging to the alligator-gar (*Lepisosteus tristœchus*), a fish abundant in the lower Mississippi river.

The scales of this fish, which Du Pratz[2] calls *poisson-armé*, are said by him

[1] "Certain Aboriginal Mounds of the Black Warrior River," Journ. Acad. Nat. Sci., Vol. XIII p. 241 *et seq.*

[2] Histoire de la Louisiane, Vol. II, p. 168, Paris, 1758.

sometimes to have served as points for the arrows of aborigines of the lower Mississippi region. Certain it is that the ganoid scales of the alligator-gar, a fish which sometimes reaches a length of from 8 to 10 feet, would be admirably suited for use as projectile points.

Mound H, five trial-holes.

Mound I, which had been much dug into previously, received four trial-holes.

Mound J, summit plateau 76 feet by 80 feet. Nine trial-holes were sunk into the summit plateau of this mound, resulting in the discovery of a badly decayed skeleton of an adult, at full length on the back, 2.5 feet below the surface.

Ten trial-holes were put into Mound K. A number of fish-scales were found, probably belonging to a young alligator-gar. These scales were too small to have served as arrowpoints, and, moreover, they lay one overlapping the other as if a portion of the fish had been present originally.

Just below the surface of Mound K were three small, coarse, undecorated pots of earthenware, all with flat bottoms. Near these, together, were two small pots, one with two loop-handles, the other with loop-handles on two opposite sides and projections below the rim on two other sides.

With these pots was a small fragment of excellent yellow ware, having part of a design in low relief, painted red.

Ten trial-holes were dug into Mound L. A much-decayed skeleton of an infant was met with about 2 feet below the surface.

Mound M, five trial-holes.

Mound N, ten trial-holes.

Mound O, nine trial-holes.

In the level ground five trial-holes were dug at each of the following sites:

Ridge ESE. of mound J.

Ground adjacent to the SW. corner of Mound C.

Dwelling-site about 40 feet NNE. of Mound D.

Dwelling-site about 100 feet from W. side of Mound J.

Field W. of Mound J.

Field E. of Mound J.

Ground NE. of Mound N.

Field W. of Mound O.

Dwelling-site NE. of Mound C (across the road).

Throughout the digging, sherds were rarely met with. Such as were found in the trial-holes, and those encountered on the surface, were mainly of common ware, though a few, including one we have already described, were of excellent material—one fragment of black ware having an especially high polish on both sides.

Decoration, when present, almost invariably consisted of simple designs rudely incised. Decoration with red paint was several times found. Two specimens tested by Dr. H. F. Keller showed the pigment to be red oxide of iron.

On the surface were a small chisel wrought from a pebble of chert, and a disc

of pottery which had been given its form before baking and had not been cut from a fragment of an earthenware vessel.

From the trial-holes came musselshells which have been identified by Dr. H. A. Pilsbry as *Quadrula perplicata ; Q. heros ; Lampsilis anodontoides.*

We are at a loss to account for our limited success in finding burials and artifacts in the neighborhood of the Blum mounds. We know that domiciliary mounds, such as those forming this group probably were, are often without burials in their summit plateaus, but one would expect to find cemeteries in the surrounding level ground. Did such cemeteries still exist in the neighborhood of the mounds, it is curious we failed to find them—for it is rarely one digs to any extent among skeletons, wholly or in part extended, without encountering some of them.

If cemeteries underlie the cultivated fields (and practically all the territory near the mounds has been under cultivation for a long time) one would look for numerous accounts of the finding of bones and artifacts in post-holes, in trenching, and in cultivation; but such accounts, as we have seen, are not forthcoming.

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